DEPARTMENT OF HOMELAND SECURITY
UNITED STATES COAST GUARD
SHORE MAINTENANCE COMMAND

# SPECIFICATIONS
# FOR
# CONSTRUCT BMF
# U.S. COAST GUARD STATION
# HOBUCKEN
# HOBUCKEN, NORTH CAROLINA

MARCH 2015

COMMANDING OFFICER
UNITED STATES COAST GUARD
CIVIL ENGINEERING UNIT, RM 2179
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DIVISION 1
(April 2014 Version)

SECTION 01 11 00
SCOPE OF WORK

1. WORK INCLUDED: Major items of work shall include the following:

1.1 Base Work Items:

1.1.1 Demolition: Completely demolish and remove three buildings in their entirety located at U.S. Coast Guard Station Hobucken, Hobucken, NC. The three buildings are the Bos'n Hole Workshop (OS2), the Shop/Storage Building (OS1) and the Guard Shack (OU1).

1.1.1.1 The Bos'n Hole Workshop (OS2) is a slab on grade, steel pre-engineered metal building structure with wood siding exterior and asphalt shingle roof on wood decking. Interior finishes consist of gypsum board and wood paneling on wood stud partitions and suspended gypsum board ceiling. The Bos'n Hole Workshop is approximately 725 SF.

1.1.1.2 The Shop/Storage Building (OS1) is a slab on grade, masonry (brick and concrete masonry) load bearing structure with asphalt shingle mansard and low slope roll roof on steel joist and deck roof structure. Interior finishes are painted concrete masonry with painted exposed structure ceiling. The Shop/Storage Building is approximately 400 SF.

1.1.1.3 The Guard Shack (OU1) is a pre-manufactured building attached to a slab on grade. Exterior finishes consist of metal frame and panels with single-paned glazing. Interior finishes are resilient tile, gypsum board and plastic laminate shelving. The Guard Shack is approximately 25 SF.

1.1.2 New Construction: Work includes the construction of a Boat Maintenance Facility (BMF) located at the U.S. Coast Guard Station Hobucken, Hobucken, NC. The BMF shall be a concrete slab-on-grade with ground-faced concrete masonry knee wall and pre-engineered metal building structure.

1.1.2.1 Exterior Finishes: Pre-finished ground-faced masonry, pre-finished metal wall and roof panels.

1.1.2.2 Interior Finishes: Painted concrete masonry, pre-finished metal wall panels and exposed metal decking and structure.

1.1.2.3 Doors and Windows: Two 14'x14' automatic overhead coiling doors located at each end of the work bay. Fiberglass personnel doors and frames at exterior and interior locations. Windows shall be PVC sliding windows with insulating glass.

1.1.2.4 HVAC: Electric infrared heaters shall be provided in the shop areas. Exhaust shall be provided for the shop area and the restroom/shower. Restroom/Shower to be climate controlled with split system heat pump.

1.1.2.5 Electrical: Electrical (service, power, lighting, emergency power etc.), fire alarm and telecommunications work for the building shall be provided.

1.2 Unit Bid Items:

1.2.1 Unit Bid Item 1: Provide a steel framed mezzanine with metal railings. Two alternating tread stairs shall be provided for access.

2. DOCUMENTS: These specifications and accompanying drawings and other documentss 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.

2.1 Construction Drawings: CG DWG. 8244-D Sheets 1 thru 32

2.2 Reference Documents: "Asbestos and Lead Assessment Services Report" dated October 21, 2014
"Geotechnical Engineering Report" dated November 21, 2014

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 Coast Guard Personnel: Coast Guard personnel (or other parties acting on the behalf of the Coast Guard) will install and connect communications/security and electronic equipment/radios/telephone and antennas, and pull wiring for these systems.

1.2 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.

1.3 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 14 00
## CONTRACTOR WORK HOURS

1. WORK HOURS: Accomplish work during normal unit operational hours of 7:30 a.m. to 4:30 p.m., Monday through Friday unless otherwise approved by the Coast Guard. Note any departures from these work hours on the Daily Reports.

2. 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.

3. 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 verify existing conditions with MK1 Joseph Lawrence, USCG Station Hobucken, Hobucken, NC at (252) 745-4000; joseph.c.lawrence@uscg.mil.

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 lessor 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.

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.

SECTION 01 33 00
SUBMITTAL PROCEDURES

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. 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.

3.1 **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.

4. 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.

4.1 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 MK1 Joseph Lawrence, USCG Station Hobucken, Hobucken, NC at (252) 745-4000; joseph.c.lawrence@uscg.mil., 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.

4. HAZARD FENCING: Special fencing 4 foot high shall be installed to prevent small children or pets from entering the work area when within 300 feet of family housing or for special hazards as shown on the drawings.

## 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 http://www.epa.gov/epaoswer/non-hw/procure/products.htm .

3. CONTRACTOR RESPONSBILITY: 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.

## SECTION 01 66 16
## 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.

## SECTION 01 71 33
## 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.

## LIST OF SUBMITTALS

| SECT | PARA | ITEM | KEY | GENERAL USE COLUMN |
|---|---|---|---|---|
| 01 14 14 | 1 | Pre-Con Site Conditions | | |
| 01 32 16 | 1.a | Construction Schedule | | |
| | 1.b | Schedule of Values | | |
| | 2.a | Progress Schedule | | |
| 01 35 29 | 3 | Safety Plan | | |
| 01 51 13 | 1 | Lockout/Tagout Plan | | |
| 01 54 30 | 1 | Confined Space Entry Plan | | |
| 01 57 23 | 1.1 | State Implementation Documentation | | |
| | 1.2 | Notarized Letter | | |
| | 1.3 | VOC rating documentation | | |
| | 2 | Spill Response Plan | | |
| 01 66 13 | 4 | Hazardous Waste Documents | | |
| 01 66 16 | 1 | SDS | | |
| | 3 | Protective Measures | | |
| 01 78 00 | 5 | As-Built Drawings | | |
| 01 78 23 | 1 | Operating Instructions | | |
| | 2 | Verification of Training | | |
| 02 41 00 | 1.6 | Notifications | | |
| | 1.9 | Existing Conditions | | |
| | 3.3.3 | Disposal of Ozone Depleting Substances | | |
| 03 30 00 | 1.6.1.1 | Reinforcing Steel | | |
| | 1.6.2.1 | Concrete Mix Design | | |
| | 2.3.1 | Mix Design | | |
| | 2.4.3 | Aggregates | | |
| | 2.4.5 | Admixtures | | |
| | 2.4.7 | Materials for Curing Concrete | | |
| | 3.6 | Batch Tickets | | |
| | 3.11.2.3 | Compressive Strength Tests | | |
| | 3.11.2.4 | Air Content | | |
| 04 20 00 | 1.4.2 | Cold Weather Installation | | |
| | 2.1 | Certificates of Compliance | | |
| | 2.2 | Concrete Masonry Units (CMU) | | |
| | 2.3.3 | Masonry Cement | | |
| | 2.3.4 | Pre-mixed Mortar | | |
| | 2.4 | Water-Repellant Admixture | | |
| | 2.5.1 | Admixtures for Grout | | |
| | 2.6 | Anchors, Ties, and Bar Positioners | | |
| | 2.7 | Joint Reinforcement | | |
| | 3.12.1 | Single-Wythe Masonry Wall Water Penetration Test | | |
| 05 12 00 | 1.3 | AISC Fabrication Plant Quality Certification | | |

## LIST OF SUBMITTALS

| SECT | PARA | ITEM | KEY | GENERAL USE COLUMN |
|---|---|---|---|---|
| 05 12 00 | 1.4.1.1 | Erection Drawings | | |
| | 1.4.2 | Fabrication Drawings | | |
| | 1.4.3.1 | Welding Procedures and Qualifications | | |
| | 2.2 | Steel | | |
| | 2.3 | Bolts, Nuts, and Washers | | |
| | 2.3.1.3 | Direct Tension Indicator Washers | | |
| | 2.6.1 | Shop Primer | | |
| 05 40 00 | 1.4 | Load-Bearing Cold-Formed Metal Framing | | |
| | 1.6.1 | Framing Components | | |
| | 1.6.2 | Metal Framing Calculations | | |
| | 2.1 | Joists | | |
| | 3.1.1 | Welds | | |
| 05 50 13 | 2.3 | Gratings and Walkways | | |
| | 3.2 | Fabrication Drawings | | |
| 05 51 33 | 2.3 | Alternating Tread Ladders | | |
| 05 52 00 | 1.3.1 | Welding Procedures | | |
| | 1.3.2 | Welder Qualifications | | |
| | 2.1 | Drawings | | |
| | 2.1 | Iron and Steel Hardware | | |
| | 2.1 | Steel Shapes, Plates, Bars and Strips | | |
| | 2.5 | Protective Coating | | |
| | 2.6 | Steel Railings and Handrails | | |
| | 3.1 | Installation Instructions | | |
| 07 21 16 | 2.1 | Blanket Insulation | | |
| | 2.2 | Accessories | | |
| | 3.1.1 | Insulation | | |
| 07 60 00 | 3.1.9 | Sill Flashing | | |
| | 3.1.10 | Covering on Flat, Sloped, or Curved Surfaces | | |
| 07 92 00 | 1.6 | Warranty | | |
| | 2.1 | Sealants | | |
| | 2.2 | Primers | | |
| | 2.3 | Bond Breakers | | |
| | 2.4 | Backstops | | |
| 08 22 20 | 2.2.1 | Doors | | |
| | 2.2.1 | Frames | | |
| | 2.4.1 | Calculations | | |
| | 2.4.1 | Insulation Materials | | |
| | 3.4 | Warranty | | |
| 08 33 23 | 1.3 | Guides | | |
| | 1.3 | Installation Drawings | | |
| | 1.4 | Warranty | | |

## LIST OF SUBMITTALS

| SECT | PARA | ITEM | KEY | GENERAL USE COLUMN |
|---|---|---|---|---|
| 08 33 23 | 1.4 | Hood | | |
| | 1.4 | Materials | | |
| | 1.4 | Devices | | |
| | 1.4 | Procedures | | |
| | 1.4 | Manufacture’s Brochures | | |
| | 1.4 | Parts Lists | | |
| | 2.3 | Overhead Coiling Doors | | |
| | 2.3.3 | Bottom Bars | | |
| | 2.3.9 | Overhead Drum | | |
| | 2.4 | Hardware | | |
| | 2.5 | Counterbalancing Mechanism | | |
| | 2.5.1 | Mounting Brackets | | |
| | 2.6 | Electric Door Operators | | |
| | 3.2.2 | Cleaning | | |
| | 3.3 | Operation and Maintenance Manuals | | |
| 08 53 00 | 2.2.1 | Windows | | |
| | 2.4.2 | Hardware | | |
| | 2.4.3 | Weatherstripping | | |
| | 2.4.4 | Screens | | |
| | 2.4.6 | Fasteners | | |
| | 2.4.7 | Accessories | | |
| 08 71 00 | 1.3 | Hardware Schedule | | |
| | 1.4 | Key Bitting | | |
| | 2.3 | Hardware Items | | |
| | 2.3.5 | Keying System | | |
| | 3.1 | Installation | | |
| 08 81 00 | 1.3 | Glazing Accessories | | |
| | 1.6.1 | Insulating Glass Warranty | | |
| | 2.2 | Insulating Glass Units | | |
| | 2.3 | Setting and Sealing Materials | | |
| | 3.2 | Glass Setting | | |
| 09 29 00 | 2.1 | Asbestos Free Materials | | |
| | 2.1 | Material Safety Data Sheets | | |
| | 2.1 | Manufacturer Maintenance Instructions | | |
| | 2.1.1 | Gypsum Board | | |
| | 2.1.2 | Joint Treatment Materials | | |
| 09 90 00 | 1.3 | Applicator’s Qualifications | | |
| | 1.5 | Color | | |
| | 2.1 | Coating | | |
| | 2.1 | Manufacturer’s Technical Data Sheets | | |
| | 3.5.2 | Mixing | | |
| 10 28 13 | 1.4 | Warranty | | |
| | 2.1.2 | Finishes | | |

## LIST OF SUBMITTALS

| SECT | PARA | ITEM | KEY | GENERAL USE COLUMN |
|---|---|---|---|---|
| 10 28 13 | 2.2 | Accessory Items | | |
| 10 44 16 | 2.1 | Fire Extinguishers | | |
| | 2.1 | Fire Extinguishers Manufacturers Data | | |
| | 2.1 | Manufacturer's Warranty with Inspection Tag | | |
| | 2.4 | Accessories | | |
| | 2.5 | Wall Brackets | | |
| | 3.2.1 | Replacement Parts | | |
| 13 12 10 | 1.5 | Warranty | | |
| | 2.1 | Fiberglass Enclosure | | |
| 13 34 19 | 1.6.1.a | Detail Drawings | | |
| | 1.6.1.a | Descriptive and Technical Literature | | |
| | 1.6.1.c | Qualification of Manufacturer | | |
| | 1.6.1.c | Qualification of Erector | | |
| | 1.6.1.c | Manufacturer's Catalog Data | | |
| | 1.6.1.c | Building Design Analysis | | |
| | 1.6.1.e | Coatings and Base Metals | | |
| | 1.6.1.e | Factory Color Finish Performance Requirements | | |
| | 1.6.1.e | System Components | | |
| | 1.6.1.h | Galvanizing Repair Paint | | |
| | 1.6.3 | Manufacturer's Qualifications | | |
| | 1.7 | Shipping, Handling, and Storage | | |
| | 1.10.1 | Building System Standard Warranty | | |
| | 1.10.2 | Roof System Weather-Tightness Standard Warranty | | |
| | 1.10.3 | Roof and Wall Panel Finish Standard Warranty | | |
| | 2.4.3 | Manufacturer's Color Charts and Chips | | |
| | 2.4.3.f | Test Reports | | |
| | 3.4 | Metal Wall Panel Installation | | |
| | 3.5 | Roof Panel Installation | | |
| | 3.12.1 | Manufacturer's Standard Warranty | | |
| | 3.12.2 | Contractor's Standard Warranty for Installation | | |
| 22 00 00 | 1.3 | Materials | | |
| | 2.2 | Fixtures | | |
| | 3.5 | Tests, Flushing and Disinfection | | |
| 23 00 00 | 2.4.1 | Duct Connectors | | |
| | 2.4.2.1 | Diffusers | | |
| | 2.4.2.3 | Registers and Grilles | | |
| | 2.5.1.1 | Centrifugal Type Power Roof Ventilators | | |
| | 2.5.1.2 | In-Line Centrifugal Fans | | |
| 23 03 00 | 1.4.2 | Alternative Qualifications | | |

## LIST OF SUBMITTALS

| SECT | PARA | ITEM | KEY | GENERAL USE COLUMN |
|---|---|---|---|---|
| 23 03 00 | 1.4.3 | Service Support | | |
| 23 05 93 | 1.2.l | TAB Team Field Leader | | |
| | 1.2.m | TAB Team Engineer | | |
| | 1.2.n | TAB Team Assistants | | |
| | 1.3.A | Records of Existing Conditions | | |
| | 1.3.A | Equipment and Performance Data | | |
| | 1.3.3.B | Systems Readiness Check | | |
| | 1.3.3.C | TAB Schematic Drawings and Reports | | |
| | 1.5.1 | Independent TAB Agency and Personnel Qualifications | | |
| | 1.5.2.A | Calibration | | |
| | 1.5.2.B | TAB Procedures | | |
| | 1.5.3 | DALT Reports | | |
| | 1.5.3.1 | TAB Firm | | |
| | 1.5.3.2 | TAB Specialist | | |
| | 1.5.3.4 | TAB Related HVAC Submittals | | |
| | 1.5.4 | TAB Execution | | |
| | 1.5.4.3.e.2 | TAB Verification | | |
| | 1.5.5.2 | TAB Reports | | |
| | 1.6.1 | DALT and TAB Submittal and Work Schedule | | |
| | 1.6.3 | Prerequisite HVAC Work Check Out List | | |
| | 3.6 Appendix. B.1 | DALT and TAB Work Execution Schedule | | |
| | 3.6 Appendix B.2 | DALT and TAB Procedures Summary | | |
| | 3.6 Appendix C | Advance Notice of TAB Field Work | | |
| 23 09 53 | 1.5.1 | Control system diagrams | | |
| | 1.5.2 | Ladder diagrams | | |
| | 1.5.3 | Operating parameters | | |
| | 1.5.4 | Wiring diagram | | |
| | 1.5.5 | Sequence of operation | | |
| | 1.5.6 | Arrangement drawing | | |
| | 1.7.5 | Site testing procedures | | |
| | 1.7.6 | Space temperature control system | | |
| | 2.2 | Fire protection devices | | |
| | 2.3 | Thermostats | | |
| | 2.4 | Indicating devices | | |
| | 2.5 | Control panels | | |

## LIST OF SUBMITTALS

| SECT | PARA | ITEM | KEY | GENERAL USE COLUMN |
|---|---|---|---|---|
| 23 09 53 | 3.3.4 | Certification of completion | | |
| | 3.3.5 | Performance verification test | | |
| | 3.4 | Training Schedule | | |
| | 3.5 | Qualified service organization list | | |
| 23 23 00 | 2.2 | Refrigerant Piping System | | |
| 23 31 13 | 1.2.B | Equipment and performance data | | |
| | 1.6.A | Connection Drawings | | |
| | 1.6.B | Record Drawings | | |
| | 2.1.1 | Galvanized Steel Ductwork materials | | |
| | 2.1.2 | Brazing materials | | |
| | 2.1.3 | Mill-Rolled reinforcing and supporting materials | | |
| | 2.2.1 | Round sheet metal duct fittings | | |
| | 2.2.4 | Turning vanes | | |
| | 2.2.6 | Flexible connectors | | |
| | 2.2.9 | Flexible duct materials | | |
| | 2.2.10 | Manual volume dampers | | |
| | 2.2.11 | Gravity backdraft and relief dampers | | |
| | 3.4.2 | Ductwork leakage tests | | |
| | 3.6 | Operation and Maintenance Manuals | | |
| 23 82 02 | 1.4 | Drawings | | |
| | 2.1.1 | Materials and Equipment | | |
| | 2.7.1.1 | Coil Corrosion Protection | | |
| 26 08 00 | 1.4.1 | Qualifications | | |
| | 1.4.3 | Acceptance Test and Inspections Procedures | | |
| | 3.1 | Acceptance Tests and Inspections | | |
| 26 20 00 | 1.5.1 | Electrical Systems | | |
| | 2.8 | Switches | | |
| | 2.9 | Fuses | | |
| | 2.10 | Receptacles | | |
| | 2.11 | Panelboards | | |
| | 2.11.3 | Circuit Breakers | | |
| | 2.12 | Enclosed Circuit Breakers | | |
| | 2.13 | Motor Controllers | | |
| | 2.14 | Manual Motor Starters | | |
| | 2.23 | Wireways | | |
| | 2.24 | Surge Protective Devices | | |
| | 3.5.2 | 600-Volt Wiring Test | | |
| | 3.5.3 | Ground-Fault Receptacle Test | | |
| | 3.5.4 | Grounding System Test | | |
| 26 28 01 | 1.4.1 | System Coordinator | | |
| | 1.6 | Devices and Equipment | | |

## LIST OF SUBMITTALS

| SECT | PARA | ITEM | KEY | GENERAL USE COLUMN |
|---|---|---|---|---|
| 26 28 01 | 2.1 | Equipment | | |
| | 2.4.4 | Fault Current Analysis | | |
| | 2.4.5 | Protective Device Coordination Study | | |
| | 3.2 | Installation | | |
| | 3.4 | Field Testing | | |
| 26 32 13 | 1.3.1 | Engine-Generator Set Data | | |
| | 1.3.2 | Engine-Generator Set Efficiencies | | |
| | 1.3.3 | Diesel Engine Data | | |
| | 1.3.4 | Generator and Exciter Data | | |
| | 1.3.5 | Calculations for Brake Mean Effective Pressure | | |
| | 1.3.6 | Torsional Vibration Stree Analysis Computations | | |
| | 1.3.7 | Capcacity Calculations for Batteries | | |
| | 1.5.1.1 | Engine-Generator Set and Auziliary Equipment | | |
| | 1.5.2 | Vibration Isolation Syste | | |
| | 1.5.3 | Fuel System | | |
| | 1.8.2 | Poseted Operating Instructions | | |
| | 2.1 | Diesel Engine-Generator Set | | |
| | 2.2 | Auxiliary Systems and Equipment | | |
| | 2.6.1 | Engine Tests | | |
| | 2.6.2 | Generator Tests | | |
| | 2.6.3 | Assembled Engine-Generator Set Tests | | |
| | 3.3 | Start-Up Engineer | | |
| | 3.4.3 | Preliminary Assembled Operation and Maintenance Manuals | | |
| | 3.4.4 | Functional Acceptance Test Procedures | | |
| | 3.5.1 | Acceptance Checks and Tests | | |
| | 3.5.2 | Functional Acceptance Tests | | |
| | 3.6.1 | Instructor’s | | |
| | 3.6.2 | Training Plan | | |
| 26 36 23 | 1.4.1 | Proof of Listing | | |
| | 1.4.2 | Automatic Transfer Switch Drawings | | |
| | 2.1 | Automatic Transfer Switches | | |
| | 3.3.1 | Acceptance Checks and Tests | | |
| | 3.3.2 | Functional Acceptance Tests | | |
| 26 51 00 | 1.5.1 | Fluorescent Electronic Ballast | | |
| | 1.5.3.3 | Energy Efficiency | | |
| | 1.6 | Warranty | | |
| | 1.6.1 | Electronic Ballast Warranty | | |
| | 1.7 | Operational Service | | |
| | 1.8.1 | Local/Regional Materials | | |
| | 2.2 | Fluorescent Lighting Fixtures | | |

## LIST OF SUBMITTALS

| SECT | PARA | ITEM | KEY | GENERAL USE COLUMN |
|---|---|---|---|---|
| 26 51 00 | 2.2.2 | Fluorescent Lamps | | |
| | 2.3 | Incandescent Lighting Fixtures | | |
| | 2.9 | Exit Signs | | |
| | 2.10 | Emergency Lighting Equipment | | |
| | 2.11 | Occupancy Sensors | | |
| | 3.3 | Operating Test | | |
| | 3.4 | Operational Tests | | |
| 26 56 00 | 1.5.1.1 | Luminaire Drawings | | |
| | 1.5.2 | Photometric Plan | | |
| | 1.5.3 | Design Data for Luminaires | | |
| | 1.5.4 | LED Luminaire – IES LM-79 Test Report | | |
| | 1.5.5 | LED Light Source – IES LM-80 Test Report | | |
| | 1.6.1 | LED Luminaire Warranty | | |
| | 1.6.1 | Luminaire Useful Life Certificate | | |
| | 1.7 | Operational Service | | |
| | 2.2.2 | Luminaire Light Sources | | |
| | 2.2.3 | Luminaire Power Supply Units (Drivers) | | |
| | 2.3.1 | Photocell | | |
| | 2.4 | Brackets | | |
| | 3.2 | Operating Test | | |
| 28 31 64 | 1.2.2 | Low Battery Voltage | | |
| | 1.4.1 | Qualifications | | |
| | 1.4.2 | Detail Drawings | | |
| | 1.5 | Technical Data and Computer Software | | |
| | 1.7 | Special Tools and Spare Parts | | |
| | 2.4 | Storage Batteries | | |
| | 2.8.3 | Combination Audible/Visual Notification Appliances | | |
| | 3.6 | Training | | |
| | 3.6 | Operating and Maintenance Instructions | | |
| | 3.7 | Testing | | |
| 31 23 00 | 1.6 | Borrow Site Testing | | |
| 31 23 00 | 3.12.2.1 | Fill and Backfill | | |
| | 3.12.2.3 | Porous Fill | | |
| | 3.12.2.4 | Density Tests | | |
| 31 31 16 | 1.2.1 | Qualifications | | |
| | 1.5 | Warranty | | |
| | 2.1 | Termiticides | | |
| | 3.1 | Verification and Measurement | | |
| 32 11 24 | 3.4.2.1 | Gradation | | |
| | 3.4.2.2 | Smoothness | | |
| | 3.4.2.3 | Density | | |

## LIST OF SUBMITTALS

| SECT | PARA | ITEM | KEY | GENERAL USE COLUMN |
|---|---|---|---|---|
| 32 12 17 | 1.3 | Certifications | | |
| | 1.6 | Construction Equipment | | |
| | 3.5.2.1 | Bituminous Mix Tests | | |
| | 3.5.2.2 | Pavement Courses | | |
| 32 13 13 | 1.5.1 | Ready-Mixed Concrete Plant | | |
| | 1.5.2 | Laboratory Test Reports | | |
| | 1.5.3 | Batch Tickets | | |
| | 2.1.2 | Curing Materials | | |
| | 2.2 | Mix Design | | |
| | 3.5.2 | Concrete Slump Tests | | |
| | 3.5.3 | Flexural Strength Tests | | |
| | 3.5.4 | Air Content Tests | | |
| 32 92 19 | 2.1 | Seed | | |
| | 2.4 | Fertilizer | | |
| | 2.5.3 | Wood Cellulose Fiber Mulch | | |
| 33 11 00 | 2.1 | Water Service Line | | |
| | 2.1.1 | Piping Materials | | |
| | 2.1.2.3 | Disinfection | | |
| | 3.1.1 | Installation | | |
| 33 30 00 | 2.1 | Pipeline Materials | | |
| | 2.3 | Reports | | |
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**CONTRACT ITEM ACCEPTANCE REQUEST**

**Contract Number: HSCG83-** **DO/TO: HSCG83-**

**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**

| Item No. | Spec Section and Paragraph | Description of Material Include Type, Model #, Manufacturer, Etc. | Deviation | Status |
|---|---|---|---|---|
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STATUS ABBREVIATION GUIDE:
AC - Accepted
AC w/ CMT - Accepted with Comment
R-Resubmit
**Comments**:

| Typed Name & Title | Signature | Date |
|---|---|---|
| | | |

**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.

SECTION 02 41 00
DEMOLITION

PART 1 GENERAL

1.1 REFERENCES

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

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

| | |
|---|---|
| AHRI Guideline K | (2009) Guideline for Containers for Recovered Non-Flammable Fluorocarbon Refrigerants |

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

| | |
|---|---|
| AASHTO M 145 | (1991; R 2008) Standard Specification for Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes |
| AASHTO T 180 | (2010) Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop |

AMERICAN SOCIETY OF SAFETY ENGINEERS (ASSE/SAFE)

| | |
|---|---|
| ASSE/SAFE A10.6 | (2006) Safety Requirements for Demolition Operations |

U.S. ARMY CORPS OF ENGINEERS (USACE)

| | |
|---|---|
| EM 385-1-1 | (2008; Errata 2011) Safety and Health Requirements Manual |

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

| | |
|---|---|
| 40 CFR 61 | National Emission Standards for Hazardous Air Pollutants |
| 40 CFR 82 | Protection of Stratospheric Ozone |

1.2 PROJECT DESCRIPTION

1.2.1 General Requirements

Do not begin demolition until authorization is received from the Contracting Officer's Representative. Remove rubbish and debris from the project site; do not allow accumulations inside or outside the buildings. The work includes demolition, salvage of identified items and materials, and removal of resulting rubbish and debris. Remove rubbish and debris from Government property daily, unless otherwise directed. Store materials that cannot be removed daily in areas specified by the Contracting Officer. In the interest of occupational safety and health, perform the work in accordance with EM 385-1-1, Section 23, Demolition, and other applicable Sections.

## 1.3 ITEMS TO REMAIN IN PLACE

Take necessary precautions to avoid damage to existing items to remain in place, to be reused, or to remain the property of the Government. Repair or replace damaged items as approved by the Contracting Officer's Representative. Coordinate the work of this section with all other work indicated. Construct and maintain shoring, bracing, and supports as required. Ensure that structural elements are not overloaded. Increase structural supports or add new supports as may be required as a result of any cutting, removal, or demolition work performed under this contract. Do not overload structural elements. Provide new supports and reinforcement for existing construction weakened by demolition, or removal work. Repairs, reinforcement, or structural replacement require approval by the Contracting Officer's Representative prior to performing such work.

### 1.3.1 Existing Construction Limits and Protection

Do not disturb existing construction beyond the extent indicated or necessary for installation of new construction. Provide temporary shoring and bracing for support of building components to prevent settlement or other movement. Provide protective measures to control accumulation and migration of dust and dirt in all work areas. Remove snow, dust, dirt, and debris from work areas daily.

### 1.3.2 Weather Protection

For portions of the building to remain, protect building interior and materials and equipment from the weather at all times. Where removal of existing roofing is necessary to accomplish work, have materials and workmen ready to provide adequate and temporary covering of exposed areas.

### 1.3.3 Trees

Protect trees within the project site which might be damaged during demolition or deconstruction, and which are indicated to be left in place, by a 6 foot high fence. Erect and secure fence a minimum of 5 feet from the trunk of individual trees or follow the outer perimeter of branches or clumps of trees. Replace any tree designated to remain that is damaged during the work under this contract with like-kind or as approved by the Contracting Officer.

### 1.3.4 Utility Service

Maintain existing utilities indicated to stay in service and protect against damage during demolition and deconstruction operations. Prior to start of work, utilities serving each area of alteration or removal will be shut off by the Government and disconnected and sealed by the Contractor.

### 1.3.5 Facilities

Protect electrical and mechanical services and utilities. Where removal of existing utilities and pavement is specified or indicated, provide approved barricades, temporary covering of exposed areas, and temporary services or connections for electrical and mechanical utilities. Floors, roofs, walls, columns, pilasters, and other structural components that are designed and constructed to stand without lateral support or shoring, and are determined to be in stable condition, must remain standing without additional bracing, shoring, or lateral support until demolished or deconstructed, unless directed otherwise by the Contracting Officer's Representative. Ensure that no elements determined to be unstable are left unsupported and place and secure bracing, shoring, or lateral supports as may be required as a result of any cutting, removal, or demolition work performed under this contract.

## 1.4 BURNING

The use of burning at the project site for the disposal of refuse and debris will not be permitted.

## 1.5 SUBMITTALS

Contracting Officer's written approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Existing Conditions

SD-07 Certificates

Notification

Disposal of Ozone Depleting Substances

## 1.6 QUALITY ASSURANCE

Submit timely notification of demolition projects to Federal, State, regional, and local authorities in accordance with 40 CFR 61, Subpart M. Notify the State's environmental protection agency and the Contracting Officer in writing 10 working days prior to the commencement of work in accordance with 40 CFR 61, Subpart M. Comply with federal, state, and local hauling and disposal regulations. In addition to the requirements of the "Contract Clauses," conform to the

safety requirements contained in ASSE/SAFE A10.6. Comply with the Environmental Protection Agency requirements specified. Use of explosives will not be permitted.

### 1.6.1 Dust and Debris Control

Prevent the spread of dust and debris to occupied buildings and avoid the creation of a nuisance or hazard in the surrounding area. Do not use water if it results in hazardous or objectionable conditions such as, but not limited to, ice, flooding, or pollution.

## 1.7 PROTECTION

### 1.7.1 Traffic Control Signs

Where pedestrian and driver safety is endangered in the area of removal work, use traffic barricades with flashing lights. Notify the Contracting Officer's Representative prior to beginning such work.

### 1.7.2 Protection of Personnel

Before, during and after the demolition work continuously evaluate the condition of the structure being demolished and take immediate action to protect all personnel working in and around the project site. No area, section, or component of floors, roofs, walls, columns, pilasters, or other structural element will be allowed to be left standing without sufficient bracing, shoring, or lateral support to prevent collapse or failure while workmen remove debris or perform other work in the immediate area.

## 1.8 RELOCATIONS

Perform the removal and reinstallation of relocated items as indicated with workmen skilled in the trades involved. Repair or replace items to be relocated which are damaged by the Contractor with new undamaged items as approved by the Contracting Officer's Representative.

## 1.9 EXISTING CONDITIONS

Before beginning any demolition work, survey the site and examine the drawings and specifications to determine the extent of the work. Record existing conditions in the presence of the Contracting Officer's Representative showing the condition of structures and other facilities adjacent to areas of alteration or removal. Photographs sized 4 inch will be acceptable as a record of existing conditions. Include in the record the elevation of the top of foundation walls, finish floor elevations, possible conflicting electrical conduits, plumbing lines, alarms systems, the location and extent of existing cracks and other damage and description of surface conditions that exist prior to before starting work. It is the Contractor's responsibility to verify and document all required outages which will be required during the course of work, and to note these outages on the record document. Submit survey results.

PART 2 PRODUCTS

2.1 FILL MATERIAL

a. Comply with excavating, backfilling, and compacting procedures for soils used as backfill material to fill basements, voids, depressions or excavations resulting from demolition or deconstruction of structures.

b. Fill material shall conform to the definition of satisfactory soil material as defined in AASHTO M 145, Soil Classification Groups A-1, A-2-4, A-2-5 and A-3. In addition, fill material shall be free from roots and other organic matter, trash, debris, frozen materials, and stones larger than 2 inches in any dimension.

c. Proposed fill material must be sampled and tested by an approved soil testing laboratory, as follows:

| | |
|---|---|
| Soil classification | AASHTO M 145 |
| Moisture-density relations | AASHTO T 180, Method B or D |

PART 3 EXECUTION

3.1 EXISTING FACILITIES TO BE REMOVED

3.1.1 Structures

a. Remove existing structures indicated to be removed to 2 feet below grade. Remove sidewalks, curbs, gutters and street light bases as indicated.

b. Demolish structures in a systematic manner from the top of the structure to the ground. Complete demolition work above each tier or floor before the supporting members on the lower level are disturbed. Demolish concrete and masonry walls in small sections. Remove structural framing members and lower to ground by means of derricks, platforms hoists, or other suitable methods as approved by the Contracting Officer's Representative.

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

3.1.2 Utilities and Related Equipment

3.1.2.1 General Requirements

Do not interrupt existing utilities serving occupied or used facilities, except when authorized in writing by the Contracting Officer's Representative. Do not interrupt existing utilities serving facilities occupied and used by the Government except when approved in writing and then only after temporary utility services have been approved and provided. Do not begin demolition or

deconstruction work until all utility disconnections have been made. Shut off and cap utilities for future use, as indicated.

3.1.2.2 Disconnecting Existing Utilities

Remove existing utilities, as indicated and/or uncovered by work and terminate in a manner conforming to the nationally recognized code covering the specific utility and approved by the Contracting Officer's Representative. When utility lines are encountered but are not indicated on the drawings, notify the Contracting Officer's Representative prior to further work in that area. Remove meters and related equipment and deliver to a location on the station in accordance with instructions of the Contracting Officer's Representative.

3.1.3 Paving and Slabs

Remove concrete and asphaltic concrete paving and slabs including aggregate base as indicated to a depth of 12 inches below existing adjacent grade. Provide neat sawcuts at limits of pavement removal as indicated.

3.1.4 Air Conditioning Equipment

Remove air conditioning, refrigeration, and other equipment containing refrigerants without releasing chlorofluorocarbon refrigerants to the atmosphere in accordance with the Clean Air Act Amendment of 1990. Recover all refrigerants prior to removing air conditioning, refrigeration, and other equipment containing refrigerants and dispose of in accordance with the paragraph entitled "Disposal of Ozone Depleting Substance (ODS)."

3.1.5 Cylinders and Canisters

Remove all fire suppression system cylinders and canisters and dispose of in accordance with the paragraph entitled "Disposal of Ozone Depleting Substance (ODS)."

3.1.6 Locksets on Swinging Doors

Remove all locksets from all swinging doors indicated to be removed and disposed of. Deliver the locksets and related items to a designated location for receipt by the Contracting Officer's Representative after removal.

3.1.7 Mechanical Equipment and Fixtures

Disconnect mechanical hardware at the nearest connection to existing services to remain, unless otherwise noted. Disconnect mechanical equipment and fixtures at fittings. Remove service valves attached to the unit.

3.2 CONCURRENT EARTH-MOVING OPERATIONS

Do not begin excavation, filling, and other earth-moving operations that are sequential to demolition work in areas occupied by structures to be demolished until all demolition in the area has been completed and debris removed. Fill holes, open basements and other hazardous openings.

## 3.3 DISPOSITION OF MATERIAL

### 3.3.1 Title to Materials

Except for salvaged items specified in related Sections, and for materials or equipment scheduled for salvage, all materials and equipment removed and not reused or salvaged, shall become the property of the Contractor and shall be removed from Government property. Title to materials resulting from demolition and materials and equipment to be removed, is vested in the Contractor upon approval by the Contracting Officer of the Contractor's demolition, and removal procedures, and authorization by the Contracting Officer to begin demolition. The Government will not be responsible for the condition or loss of, or damage to, such property after contract award. Showing for sale or selling materials and equipment on site is prohibited.

### 3.3.2 Reuse of Materials and Equipment

Remove and store materials and equipment indicated to be reused or relocated to prevent damage, and reinstall as the work progresses.

### 3.3.3 Disposal of Ozone Depleting Substance (ODS)

Class I and Class II ODS are defined in Section, 602(a) and (b), of The Clean Air Act. Prevent discharge of Class I and Class II ODS to the atmosphere. Place recovered ODS in cylinders meeting AHRI Guideline K suitable for the type ODS (filled to no more than 80 percent capacity) and provide appropriate labeling. Recovered ODS shall be removed from Government property and disposed of in accordance with 40 CFR 82. Products, equipment and appliances containing ODS in a sealed, self-contained system (e.g. residential refrigerators and window air conditioners) shall be disposed of in accordance with 40 CFR 82. Submit a shipping receipt or bill of lading for all containers of ozone depleting substance (ODS) shipped to the Defense Depot, Richmond, Virginia.

#### 3.3.3.1 Special Instructions

No more than one type of ODS is permitted in each container. A warning/hazardous label shall be applied to the containers in accordance with Department of Transportation regulations. All cylinders including but not limited to fire extinguishers, spheres, or canisters containing an ODS shall have a tag with the following information:

a. Activity name and unit identification code

b. Activity point of contact and phone number

c. Type of ODS and pounds of ODS contained

d. Date of shipment

e. National stock number (for information, call (804) 279-4525).

3.3.3.2 Fire Suppression Containers

Deactivate fire suppression system cylinders and canisters with electrical charges or initiators prior to shipment. Also, safety caps must be used to cover exposed actuation mechanisms and discharge ports on these special cylinders.

3.3.4 Unsalvageable and Non-Recyclable Material

Dispose of unsalvageable and non-recyclable combustible material off the site.

3.4 CLEANUP

Remove debris and rubbish from basement and similar excavations. Remove and transport the debris in a manner that prevents spillage on streets or adjacent areas. Apply local regulations regarding hauling and disposal.

3.5 DISPOSAL OF REMOVED MATERIALS

3.5.1 Regulation of Removed Materials

Dispose of debris, rubbish, scrap, and other nonsalvageable materials resulting from removal operations with all applicable federal, state and local regulations as contractually specified off the center.

3.5.2 Burning on Government Property

Burning of materials removed from demolished and deconstructed structures will not be permitted on Government property.

3.5.3 Removal from Government Property

Transport waste materials removed from demolished and deconstructed structures, except waste soil, from Government property for legal disposal. Dispose of waste soil as directed.

-- End of Section 02 41 00 --

SECTION 03 30 00
CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

| | |
|---|---|
| AASHTO M 322M/M 322 | (2010) Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement |

AMERICAN CONCRETE INSTITUTE INTERNATIONAL (ACI)

| | |
|---|---|
| ACI 301 | (2010; Errata 2011) Specifications for Structural Concrete |
| ACI 308.1 | (2011) Specification for Curing Concrete |
| ACI SP-66 | (2004) ACI Detailing Manual |
| ACI/MCP-1 | (2012) Manual of Concrete Practice Part 1 |
| ACI/MCP-2 | (2012) Manual of Concrete Practice Part 2 |
| ACI/MCP-3 | (2012) Manual of Concrete Practice Part 3 |
| ACI/MCP-4 | (2012) Manual of Concrete Practice Part 4 |

AMERICAN HARDBOARD ASSOCIATION (AHA)

| | |
|---|---|
| AHA A135.4 | (1995; R 2004) Basic Hardboard |

AMERICAN WELDING SOCIETY (AWS)

| | |
|---|---|
| AWS D1.4/D1.4M | (2011) Structural Welding Code - Reinforcing Steel |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A615/A615M | (2014) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement |

| | |
|---|---|
| ASTM A996/A996M | (2014) Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement |
| ASTM C1017/C1017M | (2013) Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete |
| ASTM C1107/C1107M | (2014) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink) |
| ASTM C1260 | (2007) Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method) |
| ASTM C143/C143M | (2012) Standard Test Method for Slump of Hydraulic-Cement Concrete |
| ASTM C150/C150M | (2012) Standard Specification for Portland Cement |
| ASTM C156 | (2011) Standard Test Method for Water Retention by Concrete Curing Materials |
| ASTM C1567 | (2013) Standard Test Method for Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method) |
| ASTM C171 | (2007) Standard Specification for Sheet Materials for Curing Concrete |
| ASTM C172/C172M | (2014) Standard Practice for Sampling Freshly Mixed Concrete |
| ASTM C173/C173M | (2014) Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method |
| ASTM C192/C192M | (2013a) Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory |
| ASTM C231/C231M | (2014) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method |
| ASTM C233/C233M | (2011) Standard Test Method for Air-Entraining Admixtures for Concrete |
| ASTM C260/C260M | (2010a) Standard Specification for Air-Entraining Admixtures for Concrete |

| | |
|---|---|
| ASTM C295/C295M | (2012) Petrographic Examination of Aggregates for Concrete |
| ASTM C309 | (2011) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete |
| ASTM C31/C31M | (2012) Standard Practice for Making and Curing Concrete Test Specimens in the Field |
| ASTM C311 | (2011b) Sampling and Testing Fly Ash or Natural Pozzolans for Use as a Mineral Admixture in Portland-Cement Concrete |
| ASTM C33/C33M | (2013) Standard Specification for Concrete Aggregates |
| ASTM C39/C39M | (2014a) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens |
| ASTM C42/C42M | (2013) Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete |
| ASTM C494/C494M | (2013) Standard Specification for Chemical Admixtures for Concrete |
| ASTM C618 | (2012a) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete |
| ASTM C920 | (2014a) Standard Specification for Elastomeric Joint Sealants |
| ASTM C94/C94M | (2014a) Standard Specification for Ready-Mixed Concrete |
| ASTM C989/C989M | (2013) Standard Specification for Slag Cement for Use in Concrete and Mortars |
| ASTM D1557 | (2012) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3) |
| ASTM D5759 | (2012) Characterization of Coal Fly Ash and Clean Coal Combustion Fly Ash for Potential Uses |
| ASTM D7116 | (2005) Standard Specification for Joint Sealants, Hot Applied, Jet Fuel Resistant Types, for Portland Cement Concrete Pavement |

| | |
|---|---|
| ASTM E1155 | (2014) Standard Test Method for Determining Floor Flatness and Floor Levelness Numbers |
| ASTM E648 | (2010e1) Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source |

CONCRETE REINFORCING STEEL INSTITUTE (CRSI)

| | |
|---|---|
| CRSI 10MSP | (2009; 28th Ed) Manual of Standard Practice |

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

| | |
|---|---|
| NIST PS 1 | (2009) DOC Voluntary Product Standard PS 1-07, Structural Plywood |

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION (NC DOT)

| | |
|---|---|
| NC DOT SHS | (2012) North Carolina Department of Transportation Standard Specification for Roads and Structures |

1.2 DEFINITIONS

a. "Cementitious material" as used herein must include all portland cement, pozzolan, fly ash and ground granulated blast-furnace.

b. "Exposed to public view" means situated so that it can be seen from eye level from a public location after completion of the building. A public location is accessible to persons not responsible for operation or maintenance of the building.

c. "Chemical admixtures" are materials in the form of powder or fluids that are added to the concrete to give it certain characteristics not obtainable with plain concrete mixes.

d. "Workability (or consistence)" is the ability of a fresh (plastic) concrete mix to fill the form/mould properly with the desired work (vibration) and without reducing the concrete's quality. Workability depends on water content, chemical admixtures, aggregate (shape and size distribution), cementitious content and age (level of hydration).

1.3 SUBMITTALS

Contracting Officer's written approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Reinforcing steel

Reproductions of contract drawings are unacceptable.

SD-03 Product Data

Admixtures

Materials for Curing Concrete

SD-05 Design Data

Concrete mix design

Thirty days minimum prior to concrete placement, submit a mix design for each strength and type of concrete. Submit a complete list of materials including type; brand; source and amount of cement, fly ash, pozzolans, ground slag and admixtures; and applicable reference specifications. Provide mix proportion data using at least three different water-cement ratios for each type of mixture, which produce a range of strength encompassing those required for each class and type of concrete required. If source material changes, resubmit mix proportion data using revised source material. Provide only materials that have been proven by trial mix studies to meet the requirements of this specification, unless otherwise approved in writing by the Contracting Officer's Representative. Indicate clearly in the submittal where each mix design is used when more than one mix design is submitted. Submit additional data regarding concrete aggregates if the source of aggregate changes. Submit copies of the fly ash, and pozzolan test results, in addition. The approval of fly ash, and pozzolan test results must be within 6 months of submittal date. Obtain acknowledgement of receipt prior to concrete placement.

SD-06 Test Reports

Concrete mix design

Compressive strength tests

Air Content

Aggregates

SD-07 Certificates

Batch Ticket

1.4 MODIFICATION OF REFERENCES

Accomplish work in accordance with ACI publications except as modified herein. Consider the advisory or recommended provisions to be mandatory. Interpret reference to the "Building Official," the "Structural Engineer," and the "Architect/Engineer" to mean the Contracting Officer's Representative.

## 1.5 DELIVERY, STORAGE, AND HANDLING

Do not deliver concrete until vapor barrier, forms, reinforcement, embedded items, and chamfer strips are in place and ready for concrete placement. ACI/MCP-2 for job site storage of materials. Protect materials from contaminants such as grease, oil, and dirt. Ensure materials can be accurately identified after bundles are broken and tags removed. Do not store concrete curing compounds or sealers with materials that have a high capacity to adsorb volatile organic compound (VOC) emissions. Do not store concrete curing compounds or sealers in occupied spaces.

### 1.5.1 Reinforcement

Store reinforcement of different sizes and shapes in separate piles or racks raised above the ground to avoid excessive rusting. Protect from contaminants such as grease, oil, and dirt. Ensure bar sizes can be accurately identified after bundles are broken and tags removed.

## 1.6 QUALITY ASSURANCE

### 1.6.1 Shop Drawings

#### 1.6.1.1 Reinforcing Steel

ACI SP-66. Indicate bending diagrams, assembly diagrams, splicing and laps of bars, shapes, dimensions, and details of bar reinforcing, accessories, and concrete cover. Do not scale dimensions from structural drawings to determine lengths of reinforcing bars. Reproductions of contract drawings are unacceptable.

### 1.6.2 Test Reports

#### 1.6.2.1 Concrete Mix Design

Submit copies of laboratory test reports showing that the mix has been successfully tested to produce concrete with the properties specified and that mix must be suitable for the job conditions. Include mill test and all other test for cement, aggregates, and admixtures in the laboratory test reports. Provide maximum nominal aggregate size, gradation analysis, percentage retained and passing sieve, and a graph of percentage retained verses sieve size. Submit test reports along with the concrete mix design. Obtain approval before concrete placement.

## 1.7 CONCRETE SAMPLING AND TESTING

Testing by the Contractor must include sampling and testing concrete materials proposed for use in the work and testing the design mix for each class of concrete. Perform quality control testing during construction.

Sample and test concrete aggregate materials proposed for use in the work in accordance with ASTM C33/C33M.

Sample and test portland cement in accordance with ASTM C150/C150M.

Sample and test air-entraining admixtures in accordance with ASTM C233/C233M.

Testing must be performed by a Grade I Testing Technician.

## PART 2 PRODUCTS

### 2.1 MATERIALS FOR FORMS

Provide wood, plywood, plastic, carton, or steel. Use plywood or steel forms where a smooth form finish is required.

#### 2.1.1 Wood Forms

Provide lumber that is square edged or tongue-and-groove boards, free of raised grain, knotholes, or other surface defects. Provide plywood that complies with NIST PS 1, B-B concrete form panels or better or AHA A135.4, hardboard for smooth form lining.

##### 2.1.1.1 Concrete Form Plywood (Standard Rough)

Provide plywood that conforms to NIST PS 1, B-B, concrete form, not less than 5/8-inch thick.

#### 2.1.2 Steel Forms

Provide steel form surfaces that do not contain irregularities, dents, or sags.

### 2.2 FORM TIES AND ACCESSORIES

The use of wire alone is prohibited. Provide form ties and accessories that do not reduce the effective cover of the reinforcement.

### 2.3 CONCRETE MIX DESIGN

#### 2.3.1 Contractor-Furnished Mix Design

ACI/MCP-1, ACI/MCP-2, and ACI/MCP-3 except as otherwise specified. Indicate the compressive strength (f'c) of the concrete for each portion of the structure(s) and as specified below.

| Location | f'c (Min. 28-Day Comp. Strength) (psi) | ASTM C33/C33M Maximum Nominal Aggregate (Size No.) | Range of Slump (inches) | Maximum Water-Cement Ratio (by weight) | Air Entr. (percent) |
|---|---|---|---|---|---|
| All areas | 3500 | 1 ½ | 3-4 | 0.45 | 5 |

Maximum slump shown above may be increased 1 inch for methods of consolidation other than vibration. Slump may be increased to 8 inches when superplasticizers are used. Provide air entrainment using air-entraining admixture. Provide air entrainment within plus or minus 1.5 percent of the value specified.

The contractor at his option may utilize NC DOT SHS Class AA. Do not change mix designs during construction.

2.3.1.1 Mix Proportions for Normal Weight Concrete

Trial design batches, mixture proportioning studies, and testing requirements for various classes and types of concrete specified are the responsibility of the Contractor. Base mixture proportions on compressive strength as determined by test specimens fabricated in accordance with ASTM C192/C192M and tested in accordance with ASTM C39/C39M. Samples of all materials used in mixture proportioning studies must be representative of those proposed for use in the project and must be accompanied by the manufacturer's or producer's test report indicating compliance with these specifications. Base trial mixtures having proportions, consistencies, and air content suitable for the work on methodology described in ACI/MCP-1. In the trial mixture, use at least three different water-cement ratios for each type of mixture, which must produce a range of strength encompassing those required for each class and type of concrete required on the project. The maximum water-cement ratio required must be based on equivalent water-cement ratio calculations as determined by the conversion from the weight ratio of water to cement plus pozzolan, and ground granulated blast-furnace slag by weight equivalency method. Design laboratory trial mixture for maximum permitted slump and air content. Each combination of material proposed for use must have separate trial mixture, except for accelerator or retarder use can be provided without separate trial mixture. Report the temperature of concrete in each trial batch. For each water-cement ratio, at least three test cylinders for each test age must be made and cured in accordance with ASTM C192/C192M and tested in accordance with ASTM C39/C39M for 7 and 28 days. From these results, plot a curve showing the relationship between water-cement ratio and strength for each set of trial mix studies. In addition, plot a curve showing the relationship between 7 and 28 day strengths.

2.3.1.2 Required Average Strength of Mix Design

The selected mixture must produce an average compressive strength exceeding the specified strength by the amount indicated in ACI/MCP-2. When a concrete production facility has a record of at least 15 consecutive tests, the standard deviation must be calculated and the required

average compressive strength must be determined in accordance with ACI/MCP-2. When a concrete production facility does not have a suitable record of tests to establish a standard deviation, the required average strength must follow ACI/MCP-2 requirements.

2.3.2 Ready-Mix Concrete

Provide concrete that meets the requirements of ASTM C94/C94M.

Ready-mixed concrete manufacturer must provide duplicate delivery tickets with each load of concrete delivered. Provide delivery tickets with the following information in addition to that required by ASTM C94/C94M:

Type and brand cement

Cement and complementary cementitious materials content in 94-pound bags per cubic yard of concrete

Maximum size of aggregate

Amount and brand name of admixtures

Total water content expressed by water cementitious material ratio

2.4 MATERIALS

2.4.1 Cement

ASTM C150/C150M, Type I or II. Provide blended cement that consists of a mixture of ASTM C150/C150M, Type II, cement and one of the following materials: ASTM C618 pozzolan or fly ash. For exposed concrete, use one manufacturer for each type of cement, fly ash, and pozzolan.

2.4.1.1 Fly Ash and Pozzolan

ASTM C618, Type N, F, or C, except that the maximum allowable loss on ignition must be 6 percent for Types N and F. Add with cement. Where the use of fly ash cannot meet the minimum level, provide the maximum amount of fly ash permittable that meets the code requirements for cement content. Report the chemical analysis of the fly ash in accordance with ASTM C311. Evaluate and classify fly ash in accordance with ASTM D5759.

High contents of supplementary cementitious materials can have some detrimental effects on the concrete properties, such as slowing excessively the strength gain rate, and delaying and increasing the difficulty of finishing. The recommended maximum content (by weight of the total cementitious material) for these materials are:

1. For fly ash or natural pozzolan: 40 percent (25 percent in cold climates)

2. For silica fume: 10 percent

2.4.1.2 Ground Granulated Blast-Furnace Slag

ASTM C989/C989M, Grade 120. Slag content must be a minimum of 70 percent by weight of cementitious material.

2.4.1.3 Portland Cement

Provide cement that conforms to ASTM C150/C150M, Type I or II. Use one brand and type of cement for formed concrete having exposed-to-view finished surfaces.

2.4.2 Water

Minimize the amount of water in the mix. The amount of water must not exceed 45 percent by weight of cementitious materials (cement + pozzolans), and in general, improve workability by adjusting the grading rather than by adding water. Water must be fresh, clean, and potable; free from injurious amounts of oils, acids, alkalis, salts, organic materials, or other substances deleterious to concrete.

2.4.3 Aggregates

ASTM C33/C33M, except as modified herein. Furnish aggregates for exposed concrete surfaces from one source. Provide aggregates that do not contain any substance which may be deleteriously reactive with the alkalies in the cement. Submit test report showing compliance with ASTM C33/C33M.

Fine and coarse aggregates must show expansions less than 0.08 percent at 16 days after casting when testing in accordance with ASTM C1260. Should the test data indicate an expansion of 0.08 percent or greater, reject the aggregate(s) or perform additional testing using ASTM C1567 using the Contractor's proposed mix design. In this case, include the mix design low alkali portland cement and one of the following supplementary cementitious materials:

1. GGBF slag at a minimum of 40 percent of total cementitious

2. Fly ash or natural pozzolan at a minimum of total cementitious of
    a. 30 percent if ($SiO_2$ plus $Al_2O_3$ plus $Fe_2O_3$) is 65 percent or more,
    b. 25 percent if ($SiO_2$ plus $Al_2O_3$ plus $Fe_2O_3$) is 70 percent or more,
    c. 20 percent if ($SiO_2$ plus $Al_2O_3$ plus $Fe_2O_3$) is 80 percent or more,
    d. 15 percent if ($SiO_2$ plus $Al_2O_3$ plus $Fe_2O_3$) is 90 percent or more.

If a combination of these materials is chosen, the minimum amount must be a linear combination of the minimum amounts above. Include these materials in sufficient proportion to show less than 0.08 percent expansion at 28 days after casting when tested in accordance with ASTM C1567.

Aggregates must not possess properties or constituents that are known to have specific unfavorable effects in concrete when tested in accordance with ASTM C295/C295M.

2.4.3.1 Aggregates/Combined Aggregate Gradation (Floor Slabs Only)

ASTM C33/C33M, uniformly graded and as follows: Nominal maximum aggregate size of 1 inch. A combined sieve analysis must indicate a well graded aggregate from coarsest to finest with not more than 18 percent and not less than 8 percent retained on an individual sieve, except that less than 8 percent may be retained on coarsest sieve and on No. 50 (0.3mm) sieve, and less than 8 percent may be retained on sieves finer than No. 50 (0.3mm). Provide sand that is at least 50 percent natural sand.

2.4.4 Nonshrink Grout

ASTM C1107/C1107M.

2.4.5 Admixtures

ASTM C494/C494M: Type A, water reducing; Type B, retarding; Type C, accelerating; Type D, water-reducing and retarding; and Type E, water-reducing and accelerating admixture. Do not use calcium chloride admixtures. Submit product data for admixtures used in concrete.

2.4.5.1 Air-Entraining

ASTM C260/C260M.

2.4.5.2 High Range Water Reducer (HRWR) (Superplasticizers)

ASTM C494/C494M, Type F and ASTM C1017/C1017M.

2.4.5.3 Pozzolan

Provide fly ash or other pozzolans used as admixtures that conform to ASTM C618.

2.4.6 Vapor Barrier

Provide vapor barrier as specified on the drawings.

2.4.7 Materials for Curing Concrete

Use water-based curing compounds, sealers, and coatings with low (maximum 160 grams/liter, less water and less exempt compounds) VOC content.

Consider the use of water based or vegetable or soy based curing agents in lieu of petroleum based products. Consider agents that are not toxic and emit low or no Volatile Organic Compounds (VOC). Consider the use of admixtures that offer high performance to increase

durability of the finish product but also have low toxicity and are made from bio-based materials such as soy, and emit low levels of Volatile Organic Compounds (VOC).

2.4.7.1 Impervious Sheeting

ASTM C171; waterproof paper, clear or white polyethylene sheeting, or polyethylene-coated burlap.

2.4.7.2 Liquid Membrane-Forming Compound

ASTM C309, white-pigmented, Type 2, Class B.

2.4.8 Joint Sealants

2.4.8.1 Horizontal Surfaces, 3 Percent Slope, Maximum

ASTM D 1190 or ASTM C920, Type M, Class 25, Use T. ASTM D7116 for surfaces subjected to jet fuel.

2.4.9 Biodegradable Form Release Agent

Provide form release agent that is colorless, biodegradable, and rapeseed oil-based or soy oil-based, with a low (maximum of 55 grams/liter (g/l)) VOC content. A minimum of 85 percent of the total product must be biobased material. Provide product that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces. Provide form release agent that does not contain diesel fuel, petroleum-based lubricating oils, waxes, or kerosene.

2.5 REINFORCEMENT

Bars, connectors, and chairs.

2.5.1 Reinforcing Bars

ACI/MCP-2 unless otherwise specified. Use deformed steel. ASTM A615/A615M and AASHTO M 322M/M 322 with the bars marked A, S, W, Grade 60; or ASTM A996/A996M with the bars marked R, Grade 60, or marked A, Grade 60.

2.5.2 Mechanical Reinforcing Bar Connectors

ACI 301. Provide 125 percent minimum yield strength of the reinforcement bar.

2.5.3 Reinforcing Bar Supports

Provide bar ties and supports of coated or non corrodible material.

2.5.4 Chairs and Bolsters: Steel

Plastic and steel may contain post-consumer or post-industrial recycled content.

2.5.5 Supports for Reinforcement

Supports include bolsters, chairs, spacers, and other devices necessary for proper spacing, supporting, and fastening reinforcing bars in place.

Legs of supports in contact with formwork must be hot-dip galvanized, or plastic coated after fabrication, or stainless-steel bar supports.

PART 3 EXECUTION

3.1 EXAMINATION

Do not begin installation until substrates have been properly constructed; verify that substrates are level.

If substrate preparation is the responsibility of another installer, notify Contracting Officer of unsatisfactory preparation before processing.

Check field dimensions before beginning installation. If dimensions vary too much from design dimensions for proper installation, notify Contracting Officer and wait for instructions before beginning installation.

3.2 PREPARATION

Determine quantity of concrete needed and minimize the production of excess concrete. Designate locations or uses for potential excess concrete before the concrete is poured.

3.2.1 General

Surfaces against which concrete is to be placed must be free of debris, loose material, standing water, snow, ice, and other deleterious substances before start of concrete placing.

Remove standing water without washing over freshly deposited concrete. Divert flow of water through side drains provided for such purpose.

3.2.2 Subgrade Under Foundations and Footings

When subgrade material is semiporous and dry, sprinkle subgrade surface with water as required to eliminate suction at the time concrete is deposited, or seal subgrade surface by covering surface with specified vapor retarder. When subgrade material is porous, seal subgrade surface by covering surface with specified vapor retarder.

3.2.3 Subgrade Under Slabs on Ground

Before construction of slabs on ground, have underground work on pipes and conduits completed and approved.

Previously constructed subgrade or fill must be cleaned of foreign materials and inspected by the Contractor for adequate compaction and surface tolerances as specified.

Actual density of top 12 inches of subgrade soil material-in-place must not be less than the following percentages of maximum density of same soil material compacted at optimum moisture content in accordance with ASTM D1557.

| SOIL MATERIAL | PERCENT MAXIMUM DENSITY |
|---|---|
| Capillary Barrier | 100 |
| Cohesionless soil material | 100 |
| Cohesive soil material | 95 |

Finish surface of capillary barrier fill under interior slabs on ground must not show deviation in excess of 1/4 inch when tested with a 10-foot straightedge parallel with and at right angles to building lines.

Finished surface of subgrade or fill under exterior slabs on ground must not be more than 0.02-foot above or 0.20-foot below elevation indicated.

Cover capillary barrier surface under interior slabs on ground with specified water-vapor barrier subgrade cover immediately prior to placing reinforcement. Install subgrade cover to avoid puncture or tear. Patch punctures or tears over 12 inches with separate sheets lapped not less than 12 inches. Seal all punctures or tears less than 12 inches with pressure-sensitive vapor barrier tape not less than 2-inches wide. Seal lapped joints with vapor barrier adhesive or pressure-sensitive vapor barrier tape not less than 2-inches wide. Lay subgrade cover sheets with not less than a 6-inch lap at edges and ends and in direction in which concrete is to be placed.

Prepare subgrade or fill surface under exterior slabs on ground as specified for subgrade under foundations and footings.

3.2.4 Formwork

Complete and approve formwork. Remove debris and foreign material from interior of forms before start of concrete placing.

3.2.5 Edge Forms and Screed Strips for Slabs

Set edge forms or bulkheads and intermediate screed strips for slabs to obtain indicated elevations and contours in finished slab surface and must be strong enough to support vibrating bridge screeds or roller pipe screeds if nature of specified slab finish requires use of such equipment. Align concrete surface to elevation of screed strips by use of strike-off templates or approved compacting-type screeds.

### 3.2.6 Reinforcement and Other Embedded Items

Secure reinforcement, joint materials, and other embedded materials in position, inspected, and approved before start of concrete placing.

## 3.3 FORMS

ACI/MCP-2. Provide forms, shoring, and scaffolding for concrete placement. Set forms mortar-tight and true to line and grade. Chamfer above grade exposed joints, edges, and external corners of concrete 0.75 inch unless otherwise indicated. Provide formwork with clean-out openings to permit inspection and removal of debris. Forms submerged in water must be watertight.

### 3.3.1 General

Construct forms to conform, within the tolerances specified, to shapes dimensions, lines, elevations, and positions of cast-in-place concrete members as indicated. Forms must be supported, braced, and maintained sufficiently rigid to prevent deformation under load.

### 3.3.2 Construction of Formwork

Provide forms that are tight to prevent leakage of cement paste during concrete placing.

Support form facing materials by structural members spaced close to prevent deflection of form facing material. Fit forms placed in successive units for continuous surfaces to accurate alignment to ensure a smooth completed surface within the tolerances specified. Where necessary to maintain the tolerances specified, such as long spans where immediate supports are not possible, camber formwork for anticipated deflections in formwork due to weight and pressure of fresh concrete and to construction loads.

Chamfer exposed joints, edges, and external corners a minimum of 3/4 inch by moldings placed in corners of column, beam, and wall forms.

Provide forms that are readily removable without impact, shock, or damage to concrete.

### 3.3.3 Coating

Before concrete placement, coat the contact surfaces of forms with a nonstaining mineral oil, nonstaining form coating compound, or two coats of nitrocellulose lacquer. Do not use mineral oil on forms for surfaces to which adhesive, paint, or other finish material is to be applied.

### 3.3.4 Reshoring

Reshore concrete elements where forms are removed prior to the specified time period. Do not permit elements to deflect or accept loads during form stripping or reshoring. Forms on columns, walls, or other load-bearing members may be stripped after 2 days if loads are not applied to the members. After forms are removed, reshore slabs and beams over 10 feet in span and cantilevers over 4 feet for the remainder of the specified time period in accordance with paragraph entitled "Removal of Forms." Perform reshoring operations to prevent subjecting concrete members to overloads, eccentric loading, or reverse bending. Provide reshoring elements with the same load-carrying capabilities as original shoring and spaced similar to original shoring. Firmly secure and brace reshoring elements to provide solid bearing and support.

### 3.3.5 Reuse

Reuse forms providing the structural integrity of concrete and the aesthetics of exposed concrete are not compromised.

### 3.3.6 Forms for Standard Rough Form Finish

Give rough form finish concrete formed surfaces that are to be concealed by other construction, unless otherwise specified.

Form facing material for standard rough form finish must be the specified concrete form plywood or other approved form facing material that produces concrete surfaces equivalent in smoothness and appearance to that produced by new concrete form plywood panels.

For concrete surfaces exposed only to the ground, undressed, square-edge, 1-inch nominal thickness lumber may be used. Provide horizontal joints that are level and vertical joints that are plumb.

### 3.3.7 Forms for Standard Smooth Form Finish

Give smooth form finish concrete formed surfaces that are to be exposed to view or that are to be covered with coating material applied directly to concrete or with covering material bonded to concrete, such as waterproofing, dampproofing, painting, or other similar coating system.

Form facing material for standard smooth finish must be the specified overlaid concrete form plywood or other approved form facing material that is nonreactive with concrete and that produce concrete surfaces equivalent in smoothness and appearance to that produced by new overlaid concrete form plywood panels.

Maximum deflection of form facing material between supports and maximum deflection of form supports such as studs and wales must not exceed 0.0025 times the span.

Provide arrangement of form facing sheets that are orderly and symmetrical, and sheets that are in sizes as large as practical.

Arrange panels to make a symmetrical pattern of joints. Horizontal and vertical joints must be solidly backed and butted tight to prevent leakage and fins.

3.3.8 Form Ties

Provide ties that are factory fabricated metal, adjustable in length, removable or snap-off type that do allow form deflection or do not spall concrete upon removal. Portion of form ties remaining within concrete after removal of exterior parts must be at least 1-1/2 inches back from concrete surface. Provide form ties that are free of devices that leave a hole larger than 7/8 inch or less than 1/2 inch in diameter in concrete surface. Form ties fabricated at the project site or wire ties of any type are not acceptable.

3.3.9 Tolerances for Form Construction

Construct formwork to ensure that after removal of forms and prior to patching and finishing of formed surfaces; provide concrete surfaces in accordance with tolerances specified in ACI/MCP-1 and ACI/MCP-2.

3.4 FORMED SURFACES

3.4.1 Preparation of Form Surfaces

Coat contact surfaces of forms with form-coating compound before reinforcement is placed. Provide a commercial formulation form-coating compound that does not bond with, stain, nor adversely affect concrete surfaces and impair subsequent treatment of concrete surfaces that entails bonding or adhesion nor impede wetting of surfaces to be cured with water or curing compounds. Do not allow excess form-coating compound to stand in puddles in the forms nor to come in contact with concrete against which fresh concrete is placed. Make thinning of form-coating compound with thinning agent of the type, in the amount, and under the conditions recommended by form-coating compound manufacturer's printed or written directions.

3.4.2 Tolerances

ACI/MCP-4 and as indicated.

3.5 PLACING REINFORCEMENT AND MISCELLANEOUS MATERIALS

ACI/MCP-2. Provide bars, wire ties, supports, and other devices necessary to install and secure reinforcement. Reinforcement must not have rust, scale, oil, grease, clay, or foreign substances that would reduce the bond. Rusting of reinforcement is a basis of rejection if the effective cross-sectional area or the nominal weight per unit length has been reduced. Remove loose rust prior to placing steel. Tack welding is prohibited.

3.5.1 General

Provide details of reinforcement that are in accordance with, and ACI/MCP-4 and as specified.

3.5.2 Vapor Barrier

Provide beneath the on-grade concrete floor slab. Use the greatest widths and lengths practicable to eliminate joints wherever possible. Lap joints a minimum of 12 inches and tape or cement joints. Remove torn, punctured, or damaged vapor barrier material and provide with new vapor barrier prior to placing concrete. Concrete placement must not damage vapor barrier material.

3.5.3 Reinforcement Supports

Place reinforcement and secure with galvanized or non corrodible chairs, spacers, or metal hangers. For supporting reinforcement on the ground, use concrete or other non corrodible material, having a compressive strength equal to or greater than the concrete being placed.

3.5.4 Splicing

Per ACI/MCP-2. Do not splice at points of maximum stress. Overlap welded wire fabric the spacing of the cross wires, plus 2 inches.

3.5.5 Cover

ACI/MCP-2 for minimum coverage, unless otherwise indicated.

3.5.6 Setting Miscellaneous Material

Place and secure anchors and bolts, pipe sleeves, conduits, and other such items in position before concrete placement. Plumb anchor bolts and check location and elevation. Temporarily fill voids in sleeves with readily removable material to prevent the entry of concrete.

3.5.7 Construction Joints

Locate joints to least impair strength. Continue reinforcement across joints unless otherwise indicated.

3.5.8 Fabrication

Shop fabricate reinforcing bars to conform to shapes and dimensions indicated for reinforcement, and as follows:

Provide fabrication tolerances that are in accordance with ACI/MCP-1, ACI/MCP-2 and ACI/MCP-3.

Provide hooks and bends that are in accordance with and ACI/MCP-3.

Reinforcement must be bent cold to shapes as indicated. Bending must be done in the shop. Rebending of a reinforcing bar that has been bent incorrectly is not be permitted. Bending must be in accordance with standard approved practice and by approved machine methods.

Tolerance on nominally square-cut, reinforcing bar ends must be in accordance with ACI/MCP-3.

Deliver reinforcing bars bundled, tagged, and marked. Tags must be metal with bar size, length, mark, and other information pressed in by machine. Marks must correspond with those used on the placing drawings.

Do not use reinforcement that has any of the following defects:

a. Bar lengths, depths, and bends beyond specified fabrication tolerances

b. Bends or kinks not indicated on drawings or approved shop drawings

c. Bars with reduced cross-section due to rusting or other cause

Replace defective reinforcement with new reinforcement having required shape, form, and cross-section area.

3.5.9 Placing Reinforcement

Place reinforcement in accordance with ACI/MCP-4.

For slabs on grade (over earth or over capillary water barrier) and for footing reinforcement, support bars on precast concrete blocks, spaced at intervals required by size of reinforcement, to keep reinforcement the minimum height specified above the underside of slab or footing.

Contractor must cooperate with other trades in setting of anchor bolts, inserts, and other embedded items. Where conflicts occur between locating reinforcing and embedded items, the Contractor must notify the Contracting Officer's Representative so that conflicts may be reconciled before placing concrete. Anchors and embedded items must be positioned and supported with appropriate accessories.

Provide reinforcement that is supported and secured together to prevent displacement by construction loads or by placing of wet concrete, and as follows:

Provide supports for reinforcing bars that are sufficient in number and sufficiently heavy to carry the reinforcement they support, and in accordance with ACI/MCP-4 and CRSI 10MSP. Do not use supports to support runways for concrete conveying equipment and similar construction loads.

Secure reinforcements to supports by means of tie wire. Wire must be black, soft iron wire, not less than 16 gage.

Reinforcement must be accurately placed, securely tied at intersections with 18-gage annealed wire, and held in position during placing of concrete by spacers, chairs, or other approved supports. Point wire-tie ends away from the form. Unless otherwise indicated, numbers, type, and spacing of supports must conform to ACI/MCP-3.

Bending of reinforcing bars partially embedded in concrete is permitted only as specified in and ACI/MCP-4.

3.5.10 Spacing of Reinforcing Bars

Spacing must be as indicated. If not indicated, spacing must be in accordance with the ACI/MCP-3.

Reinforcing bars may be relocated to avoid interference with other reinforcement, or with conduit, pipe, or other embedded items. If any reinforcing bar is moved a distance exceeding one bar diameter or specified placing tolerance, resulting rearrangement of reinforcement is subject to approval.

3.5.11 Concrete Protection for Reinforcement

Concrete protection must be in accordance with the ACI/MCP-4, ASTM E648, and ACI/MCP-3.

3.5.12 Welding

Welding must be in accordance with AWS D1.4/D1.4M.

3.6 BATCHING, MEASURING, MIXING, AND TRANSPORTING CONCRETE

ASTM C94/C94M, and ACI/MCP-2, except as modified herein. Batching equipment must be such that the concrete ingredients are consistently measured within the following tolerances: 1 percent for cement and water, 2 percent for aggregate, and 3 percent for admixtures. Furnish mandatory batch ticket information for each load of ready mix concrete.

3.6.1 Measuring

Sample and test at intervals as specified in paragraphs SAMPLING (paragraph 3.11.1) and TESTING (paragraph 3.11.2).

3.6.2 Mixing

ASTM C94/C94M and ACI/MCP-2. Machine mix concrete. Begin mixing within 30 minutes after the cement has been added to the aggregates. Place concrete within 90 minutes of either addition of mixing water to cement and aggregates or addition of cement to aggregates if the air

temperature is less than 84 degrees F. Reduce mixing time and place concrete within 60 minutes if the air temperature is greater than 84 degrees F except as follows: if set retarding admixture is used and slump requirements can be met, limit for placing concrete may remain at 90 minutes. Additional water may be added, provided that both the specified maximum slump and water-cement ratio are not exceeded. When additional water is added, an additional 30 revolutions of the mixer at mixing speed is required. If the entrained air content falls below the specified limit, add a sufficient quantity of admixture to bring the entrained air content within the specified limits. Dissolve admixtures in the mixing water and mix in the drum to uniformly distribute the admixture throughout the batch.

### 3.6.3 Transporting

Transport concrete from the mixer to the forms as rapidly as practicable. Prevent segregation or loss of ingredients. Clean transporting equipment thoroughly before each batch. Do not use aluminum pipe or chutes. Remove concrete which has segregated in transporting and dispose of as directed.

## 3.7 PLACING CONCRETE

Place concrete as soon as practicable after the forms and the reinforcement have been inspected and approved. Do not place concrete when weather conditions prevent proper placement and consolidation; in uncovered areas during periods of precipitation; or in standing water. Prior to placing concrete, remove dirt, construction debris, water, snow, and ice from within the forms. Deposit concrete as close as practicable to the final position in the forms. Do not exceed a free vertical drop of 3 feet from the point of discharge. Place concrete in one continuous operation from one end of the structure towards the other. Position grade stakes on 10 foot centers maximum in each direction when pouring interior slabs and on 20 foot centers maximum for exterior slabs.

### 3.7.1 General Placing Requirements

Deposit concrete continuously or in layers of such thickness that no concrete is placed on concrete which has hardened sufficiently to cause formation of seams or planes of weakness within the section. If a section cannot be placed continuously, provide construction joints as specified. Perform concrete placing at such a rate that concrete which is being integrated with fresh concrete is still plastic. Deposit concrete as nearly as practical in its final position to avoid segregation due to rehandling or flowing. Do not subject concrete to procedures which cause segregation.

Concrete to receive other construction must be screeded to proper level to avoid excessive skimming or grouting.

Do not use concrete which becomes nonplastic and unworkable or does not meet quality control limits as specified or has been contaminated by foreign materials. Use of retempered concrete is permitted. Remove rejected concrete from the site.

3.7.2 Footing Placement

Concrete for footings may be placed in excavations without forms upon inspection and approval by the Contracting Officer. Excavation width must be a minimum of 4 inches greater than indicated.

3.7.3 Vibration

ACI/MCP-2. Furnish a spare, working, vibrator on the job site whenever concrete is placed. Consolidate concrete slabs greater than 4 inches in depth with high frequency mechanical vibrating equipment supplemented by hand spading and tamping. Consolidate concrete slabs 4 inches or less in depth by wood tampers, spading, and settling with a heavy leveling straightedge. Operate internal vibrators with vibratory element submerged in the concrete, with a minimum frequency of not less than 6000 impulses per minute when submerged. Do not use vibrators to transport the concrete in the forms. Insert and withdraw vibrators approximately 20 inches apart. Penetrate the previously placed lift with the vibrator when more than one lift is required. Place concrete in 20 inch maximum vertical lifts. Use external vibrators on the exterior surface of the forms when internal vibrators do not provide adequate consolidation of the concrete.

3.7.4 Pumping

ACI/MCP-2. Pumping must not result in separation or loss of materials nor cause interruptions sufficient to permit loss of plasticity between successive increments. Loss of slump in pumping equipment must not exceed 2 inches. Do not convey concrete through pipe made of aluminum or aluminum alloy. Avoid rapid changes in pipe sizes. Limit maximum size of course aggregate to 33 percent of the diameter of the pipe. Limit maximum size of well rounded aggregate to 40 percent of the pipe diameter. Take samples for testing at both the point of delivery to the pump and at the discharge end.

3.7.5 Cold Weather

ACI/MCP-2. Do not allow concrete temperature to decrease below 50 degrees F. Obtain approval prior to placing concrete when the ambient temperature is below 40 degrees F or when concrete is likely to be subjected to freezing temperatures within 24 hours. Cover concrete and provide sufficient heat to maintain 50 degrees F minimum adjacent to both the formwork and the structure while curing. Limit the rate of cooling to 37 degrees F in any 1 hour and 50 degrees F per 24 hours after heat application.

3.7.6 Hot Weather

Maintain required concrete temperature using Figure 2.1.5 in ACI/MCP-2 to prevent the evaporation rate from exceeding 0.2 pound of water per square foot of exposed concrete per hour. Cool ingredients before mixing or use other suitable means to control concrete temperature and prevent rapid drying of newly placed concrete. Shade the fresh concrete as soon as possible after placing. Start curing when the surface of the fresh concrete is sufficiently hard to permit curing without damage. Provide water hoses, pipes, spraying equipment, and water

hauling equipment, where job site is remote to water source, to maintain a moist concrete surface throughout the curing period. Provide burlap cover or other suitable, permeable material with fog spray or continuous wetting of the concrete when weather conditions prevent the use of either liquid membrane curing compound or impervious sheets. For vertical surfaces, protect forms from direct sunlight and add water to top of structure once concrete is set.

3.7.7 Follow-up

Check concrete within 24 hours of placement for flatness, levelness, and other specified tolerances. Adjust formwork and placement techniques on subsequent pours to achieve specified tolerances.

3.7.8 Placing Concrete in Forms

Deposit concrete placed in forms in horizontal layers not exceeding 12 inches.

Remove temporary spreaders in forms when concrete placing has reached elevation of spreaders.

Consolidate concrete placed in forms by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping. Design vibrators to operate with vibratory element submerged in concrete and maintain a speed of not less than 9,000 impulses per minute when submerged in concrete. Provide vibrating equipment adequate in number of units and power of each unit to properly consolidate concrete. Vibration of forms and reinforcement is not permitted. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced points not farther apart than visible effectiveness of machine. Do not insert vibrator into lower courses of concrete that have begun to set. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing segregation of concrete mix.

Do not start placing of concrete in supporting elements until concrete previously placed in columns and walls is no longer plastic and has been in place a minimum of 2 hours.

3.7.9 Placing Concrete Slabs

Place and consolidate concrete for slabs in a continuous operation, within the limits of approved construction joints until placing of panel or section is completed.

During concrete placing operations, consolidate concrete by mechanical vibrating equipment so that concrete is worked around reinforcement and other embedded items and into corners. Consolidate concrete placed in beams and girders of supported slabs and against bulkheads of slabs on ground by mechanical vibrators as specified. Consolidate concrete in remainder of slabs by vibrating bridge screeds, roller pipe screeds, or other approved method. Limit consolidation operations to time necessary to obtain consolidation of concrete without bringing an excess of fine aggregate to the surface. Concrete to be consolidated must be as dry as practical and surfaces thereof must not be manipulated prior to finishing operations. Bring concrete correct

level with a straightedge and struck-off. Use bull floats or darbies to smooth surface, leaving it free of humps or hollows. Sprinkling of water on plastic surface is not permitted.

Provide finish of slabs as specified.

3.7.10 Bonding

Surfaces of set concrete at joints, except where bonding is obtained by use of concrete bonding agent, must be roughened and cleaned of laitance, coatings, loose particles, and foreign matter. Roughen surfaces in a manner that exposes the aggregate uniformly and does not leave laitance, loosened particles of aggregate, nor damaged concrete at the surface.

Obtain bonding of fresh concrete that has set as follows:

At joints between footings and walls or columns, between walls or columns and the beams or slabs they support, and elsewhere unless otherwise specified; roughened and cleaned surface of set concrete must be dampened, but not saturated, immediately prior to placing of fresh concrete.

At joints in exposed-to-view work; at vertical joints in walls; at joints near midpoint of span in girders, beams, supported slabs, other structural members; in work designed to contain liquids; the roughened and cleaned surface of set concrete must be dampened but not saturated and covered with a cement grout coating.

Provide cement grout that consists of equal parts of portland cement and fine aggregate by weight with not more than 6 gallons of water per sack of cement. Apply cement grout with a stiff broom or brush to a minimum thickness of 1/16 inch. Deposit fresh concrete before cement grout has attained its initial set.

Bonding of fresh concrete to concrete that has set may be obtained by use of a concrete bonding agent. Apply such bonding material to cleaned concrete surface in accordance with approved printed instructions of bonding material manufacturer.

3.8 SURFACE FINISHES EXCEPT FLOOR, SLAB, AND PAVEMENT FINISHES

3.8.1 Defects

Repair formed surfaces by removing minor honeycombs, pits greater than 1 square inch surface area or 0.25 inch maximum depth, or otherwise defective areas. Provide edges perpendicular to the surface and patch with nonshrink grout. Patch tie holes and defects when the forms are removed. Concrete with extensive honeycomb including exposed steel reinforcement, cold joints, entrapped debris, separated aggregate, or other defects which affect the serviceability or structural strength will be rejected, unless correction of defects is approved. Obtain approval of corrective action prior to repair. The surface of the concrete must not vary more than the allowable tolerances of ACI/MCP-4. Exposed surfaces must be uniform in appearance and finished to a smooth form finish unless otherwise specified.

3.8.2 Formed Surfaces

3.8.2.1 Tolerances

ACI/MCP-1 and as indicated.

3.8.2.2 As-Cast Rough Form

Provide for surfaces not exposed to public view. Patch these holes and defects and level abrupt irregularities. Remove or rub off fins and other projections exceeding 0.25 inch in height.

3.8.2.3 Standard Smooth Finish

Finish must be as-cast concrete surface as obtained with form facing material for standard smooth finish. Repair and patch defective areas as specified; and all fins and remove other projections on surface.

3.8.3 Surface Finish Samples

Provide a minimum of three sample concrete panels for each finish for each mix design, 3 by 3 feet, 3 inches thick. Use the approved concrete mix design(s). Provide sample panels on-site at locations directed. Once approved, each set of panels must be representative of each of the finishes specified and of the workmanship and finish(es) required. Do not remove or destroy samples until directed by the Contracting Officer's Representative.

3.9 FLOOR, SLAB, AND PAVEMENT FINISHES AND MISCELLANEOUS CONSTRUCTION

ACI/MCP-2, unless otherwise specified. Slope floors uniformly to drains where drains are provided.

3.9.1 Finish

Place, consolidate, and immediately strike off concrete to obtain proper contour, grade, and elevation before bleedwater appears. Permit concrete to attain a set sufficient for floating and supporting the weight of the finisher and equipment. If bleedwater is present prior to floating the surface, drag the excess water off or remove by absorption with porous materials. Do not use dry cement to absorb bleedwater.

3.9.1.1 Steel Troweled

Use for floors intended as walking surfaces and for reception of floor coverings. First, provide a floated finish. Next, the finish must be power troweled three times, and finally hand troweled. The first troweling after floating needs to produce a smooth surface which is relatively free of defects but which may still show some trowel marks. Perform additional trowelings done by

hand after the surface has hardened sufficiently. The final troweling is done when a ringing sound is produced as the trowel is moved over the surface. Thoroughly consolidate the surface by the hand troweling operations. The finished surface must be essentially free of trowel marks and uniform in texture and appearance. The finished surface must produce a surface level to within 1/4 inch in 10 feet. On surfaces intended to support floor coverings, remove any defects of sufficient magnitude to show through the floor covering by grinding.

3.9.1.2 Broomed

Use on surfaces of pavements and surfaces, unless otherwise indicated. Perform a floated finish, then draw a broom or burlap belt across the surface to produce a coarse scored texture. Permit surface to harden sufficiently to retain the scoring or ridges. Broom transverse to traffic or at right angles to the slope of the slab.

3.9.2 Flat Floor Finishes

3.9.2.1 Measurement of Floor Tolerances

Test slab within 24 hours of the final troweling. Provide tests to Contracting Officer's Representative within 12 hours after collecting the data. Floor flatness inspector is required to provide a tolerance report which must include:

a. Key plan showing location of data collected.

b. Results required by ASTM E1155.

3.10 CURING AND PROTECTION

ACI/MCP-2 unless otherwise specified. Begin curing immediately following form removal. Avoid damage to concrete from vibration created by blasting, pile driving, movement of equipment in the vicinity, disturbance of formwork or protruding reinforcement, and any other activity resulting in ground vibrations. Protect concrete from injurious action by sun, rain, flowing water, frost, mechanical injury, tire marks, and oil stains. Do not allow concrete to dry out from time of placement until the expiration of the specified curing period. Do not use membrane-forming compound on surfaces where appearance would be objectionable, on any surface to be painted, where coverings are to be bonded to the concrete, or on concrete to which other concrete is to be bonded. If forms are removed prior to the expiration of the curing period, provide another curing procedure specified herein for the remaining portion of the curing period. Provide moist curing for those areas receiving liquid chemical sealer-hardener or epoxy coating. Allow curing compound/sealer installations to cure prior to the installation of materials that adsorb VOCs.

3.10.1 General

Protect freshly placed concrete from premature drying and cold or hot temperature and maintain without drying at a relatively constant temperature for the period of time necessary for hydration of cement and proper hardening of concrete.

Start initial curing as soon as free water has disappeared from surface of concrete after placing and finishing. Keep concrete moist for minimum 72 hours.

Final curing must immediately follow initial curing and before concrete has dried. Continue final curing until cumulative number of hours or fraction thereof (not necessarily consecutive) during which temperature of air in contact with the concrete is above 50 degrees F has totaled 168 hours. Alternatively, if tests are made of cylinders kept adjacent to the structure and cured by the same methods, final curing may be terminated when the average compressive strength has reached 70 percent of the 28-day design compressive strength. Prevent rapid drying at end of final curing period.

3.10.2 Moist Curing

Remove water without erosion or damage to the structure. Prevent water run-off.

3.10.2.1 Impervious Sheeting

Wet the entire exposed surface of the concrete thoroughly with a fine spray of water and cover with impervious sheeting throughout the curing period. Lay sheeting directly on the concrete surface and overlap edges 12 inches minimum. Provide sheeting not less than 18 inches wider than the concrete surface to be cured. Secure edges and transverse laps to form closed joints. Repair torn or damaged sheeting or provide new sheeting. Cover or wrap columns, walls, and other vertical structural elements from the top down with impervious sheeting; overlap and continuously tape sheeting joints; and introduce sufficient water to soak the entire surface prior to completely enclosing.

3.10.3 Liquid Membrane-Forming Curing Compound

Seal or cover joint openings prior to application of curing compound. Prevent curing compound from entering the joint. Apply in accordance with the recommendations of the manufacturer immediately after any water sheen which may develop after finishing has disappeared from the concrete surface. Provide and maintain compound on the concrete surface throughout the curing period. Do not use this method of curing where the use of Figure 2.1.5 in ACI/MCP-2 indicates that hot weather conditions cause an evaporation rate exceeding 0.2 pound of water per square foot per hour.

3.10.3.1 Application

Unless the manufacturer recommends otherwise, apply compound immediately after the surface loses its water sheen and has a dull appearance, and before joints are sawed. Mechanically agitate curing compound thoroughly during use. Use approved power-spraying equipment to uniformly apply two coats of compound in a continuous operation. The total coverage for the

two coats must be 200 square feet maximum per gallon of undiluted compound unless otherwise recommended by the manufacturer's written instructions. The compound must form a uniform, continuous, coherent film that does not check, crack, or peel. Immediately apply an additional coat of compound to areas where the film is defective. Re-spray concrete surfaces subjected to rainfall within 3 hours after the curing compound application.

3.10.3.2 Protection of Treated Surfaces

Prohibit pedestrian and vehicular traffic and other sources of abrasion at least 72 hours after compound application. Maintain continuity of the coating for the entire curing period and immediately repair any damage.

3.10.4 Curing Periods

ACI/MCP-2. Begin curing immediately after placement. Protect concrete from premature drying, excessively hot temperatures, and mechanical injury; and maintain minimal moisture loss at a relatively constant temperature for the period necessary for hydration of the cement and hardening of the concrete. The materials and methods of curing are subject to approval by the Contracting Officer's Representative.

3.10.5 Curing Methods

Accomplish curing by moist curing, by moisture-retaining cover curing, by membrane curing, and by combinations thereof, as specified.

Moisture-cover curing:

Accomplish moisture-retaining cover curing by covering concrete surfaces with specified moisture-retaining cover for curing concrete. Place cover directly on concrete in widest practical width, with sides and ends lapped at least 3 inches. Weight cover to prevent displacement; immediately repair tears or holes appearing during curing period by patching with pressure-sensitive, waterproof tape or other approved method.

Membrane curing:

Accomplish membrane curing by applying specified membrane-forming curing compound to damp concrete surfaces as soon as moisture film has disappeared. Apply curing compound uniformly in a two-coat operation by power-spraying equipment using a spray nozzle equipped with a wind guard. Apply second coat in a direction at right angles to direction of first coat. Total coverage for two coats must be not more than 200 square feet per gallon of curing compound. Respray concrete surfaces which are subjected to heavy rainfall within 3 hours after curing compound has been applied by method and at rate specified. Maintain continuity of coating for entire curing period and immediately repair damage to coating during this period.

Membrane-curing compounds must not be used on surfaces that are to be covered with coating material applied directly to concrete or with a covering material bonded to concrete, such as other concrete, liquid floor hardener, waterproofing, dampproofing, membrane roofing, painting, and other coatings and finish materials.

3.10.6 Curing Formed Surfaces

Accomplish curing of formed surfaces, including undersurfaces of girders, beams, supported slabs, and other similar surfaces by moist curing with forms in place for full curing period or until forms are removed. If forms are removed before end of curing period, accomplish final curing of formed surfaces by any of the curing methods specified above, as applicable.

3.10.7 Curing Unformed Surfaces

Accomplish initial curing of unformed surfaces, such as monolithic slabs, floor topping, and other flat surfaces, by membrane curing.

Unless otherwise specified, accomplish final curing of unformed surfaces by any of curing methods specified above, as applicable.

Accomplish final curing of concrete surfaces to receive liquid floor hardener of finish flooring by moisture-retaining cover curing.

3.10.8 Temperature of Concrete During Curing

When temperature of atmosphere is 41 degrees F and below, maintain temperature of concrete at not less than 55 degrees F throughout concrete curing period or 45 degrees F when the curing period is measured by maturity. When necessary, make arrangements before start of concrete placing for heating, covering, insulation, or housing as required to maintain specified temperature and moisture conditions for concrete during curing period.

When the temperature of atmosphere is 80 degrees F and above or during other climatic conditions which cause too rapid drying of concrete, make arrangements before start of concrete placing for installation of wind breaks, of shading, and for fog spraying, wet sprinkling, or moisture-retaining covering of light color as required to protect concrete during curing period.

Changes in temperature of concrete must be uniform and not exceed 37 degrees F in any 1 hour nor 80 degrees F in any 24-hour period.

3.10.9 Protection from Mechanical Injury

During curing period, protect concrete from damaging mechanical disturbances, particularly load stresses, heavy shock, and excessive vibration and from damage caused by rain or running water.

3.10.10 Protection After Curing

Protect finished concrete surfaces from damage by construction operations.

## 3.11 FIELD QUALITY CONTROL

### 3.11.1 Sampling

ASTM C172/C172M. Collect samples of fresh concrete to perform tests specified. ASTM C31/C31M for making test specimens.

### 3.11.2 Testing

#### 3.11.2.1 Slump Tests

ASTM C143/C143M. Take concrete samples during concrete placement/discharge. The maximum slump may be increased as specified with the addition of an approved admixture provided that the water-cementitious material ratio is not exceeded. Perform tests at commencement of concrete placement, when test cylinders are made, and for each batch (minimum) or every 20 cubic yards (maximum) of concrete.

#### 3.11.2.2 Temperature Tests

Test the concrete delivered and the concrete in the forms. Perform tests in hot or cold weather conditions (below 50 degrees F and above 80 degrees F) for each batch (minimum) or every 20 cubic yards (maximum) of concrete, until the specified temperature is obtained, and whenever test cylinders and slump tests are made.

#### 3.11.2.3 Compressive Strength Tests

ASTM C39/C39M. Make five test cylinders for each set of tests in accordance with ASTM C31/C31M. Take precautions to prevent evaporation and loss of water from the specimen. Test two cylinders at 7 days, two cylinders at 28 days, and hold one cylinder in reserve. Take samples for strength tests of each mix design of and for concrete placed each day not less than once a day, nor less than once for each 160 cubic yards of concrete, nor less than once for each 5400 square feet of surface area for slabs or walls. For the entire project, take no less than five sets of samples and perform strength tests for each mix design of concrete placed. Each strength test result must be the average of two cylinders from the same concrete sample tested at 28 days. If the average of any three consecutive strength test results is less than f'c or if any strength test result falls below f'c by more than 450 psi, take a minimum of three ASTM C42/C42M core samples from the in-place work represented by the low test cylinder results and test. Concrete represented by core test is considered structurally adequate if the average of three cores is equal to at least 85 percent of f'c and if no single core is less than 75 percent of f'c. Retest locations represented by erratic core strengths. Remove concrete not meeting strength criteria and provide new acceptable concrete. Repair core holes with nonshrink grout. Match color and finish of adjacent concrete.

3.11.2.4 Air Content

ASTM C173/C173M or ASTM C231/C231M for normal weight concrete and ASTM C173/C173M for lightweight concrete. Test air-entrained concrete for air content at the same frequency as specified for slump tests.

3.11.2.5 Strength of Concrete Structure

Compliance with the following is considered deficient if it fails to meet the requirements which control strength of structure in place, including following conditions:

Failure to meet compressive strength tests as evaluated

Reinforcement not conforming to requirements specified

Concrete which differs from required dimensions or location in such a manner as to reduce strength

Concrete curing and protection of concrete against extremes of temperature during curing, not conforming to requirements specified

Concrete subjected to damaging mechanical disturbances, particularly load stresses, heavy shock, and excessive vibration

Poor workmanship likely to result in deficient strength

3.12 WASTE MANAGEMENT

As specified in the Waste Management Plan and as follows.

3.12.1 Mixing Equipment

Before concrete pours, designate Company-owned site meeting environmental standards for cleaning out concrete mixing trucks. Minimize water used to wash equipment.

3.12.2 Hardened, Cured Waste Concrete

Dispose of off site.

3.12.3 Reinforcing Steel

Collect reinforcing steel and place in designated area for recycling.

3.12.4 Other Waste

Identify concrete manufacturer's or supplier's policy for collection or return of construction waste, unused material, deconstruction waste, and/or packaging material. Return excess cement to supplier.

## 3.13 INSTALLATION OF ANCHORAGE DEVICES

### 3.13.1 General

Anchorage devices and embedded items required for other work that is attached to, or supported by, set and build in cast-in-place concrete as part of the work of this section, using setting drawings, instructions, and directions for work to be attached thereto.

### 3.13.2 Placing Anchorage Devices

Anchorage devices and embedded items must be positioned accurately and supported against displacement. Fill openings in anchorage devices such as slots and threaded holes with an approved, removable material to prevent entry of concrete into openings.

## 3.14 CONCRETE CONVEYING

### 3.14.1 Transfer of Concrete At Project Site

Handle concrete from point of delivery and transfer to concrete conveying equipment and to locations of final deposit as rapidly as practical by methods which prevent segregation and loss of concrete mix materials.

### 3.14.2 Mechanical Equipment for Conveying Concrete

Equipment must ensure a continuous flow of concrete at delivery end, as approved. Provide runways for wheeled concrete-conveying equipment from concrete delivery point to locations of final deposit. Interior surfaces of concrete conveying equipment must be free of hardened concrete, debris, water, snow, ice, and other deleterious substances.

-- End of Section 03 30 00 --

SECTION 04 20 00
MASONRY

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN CONCRETE INSTITUTE INTERNATIONAL (ACI)

| | |
|---|---|
| ACI 530/530.1 | ( 2013) Building Code Requirements and Specification for Masonry Structures and Related Commentaries |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A1064/A1064M | (2013) Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete |
| ASTM A153/A153M | (2009) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware |
| ASTM A167 | (1999; R 2009) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip |
| ASTM A615/A615M | (2014) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement |
| ASTM A641/A641M | (2009a) Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire |
| ASTM B370 | (2012) Standard Specification for Copper Sheet and Strip for Building Construction |
| ASTM B633 | (2013) Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel |
| ASTM C1019 | (2013) Standard Test Method for Sampling and Testing Grout |
| ASTM C1072 | (2013; E 2014) Standard Test Method for Measurement of Masonry Flexural Bond Strength |

| | |
|---|---|
| ASTM C1142 | (1995; R 2013) Standard Specification for Extended Life Mortar for Unit Masonry |
| ASTM C129 | (2014) Standard Specification for Nonloadbearing Concrete Masonry Units |
| ASTM C144 | (2011) Standard Specification for Aggregate for Masonry Mortar |
| ASTM C150/C150M | (2012) Standard Specification for Portland Cement |
| ASTM C207 | (2006; R 2011) Standard Specification for Hydrated Lime for Masonry Purposes |
| ASTM C270 | (2014) Standard Specification for Mortar for Unit Masonry |
| ASTM C476 | (2010) Standard Specification for Grout for Masonry |
| ASTM C494/C494M | (2013) Standard Specification for Chemical Admixtures for Concrete |
| ASTM C641 | (2009) Staining Materials in Lightweight Concrete Aggregates |
| ASTM C780 | (2014) Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry |
| ASTM C90 | (2014) Loadbearing Concrete Masonry Units |
| ASTM C91/C91M | (2012) Standard Specification for Masonry Cement |
| ASTM C94/C94M | (2014a) Standard Specification for Ready-Mixed Concrete |
| ASTM C989/C989M | (2013) Standard Specification for Slag Cement for Use in Concrete and Mortars |
| ASTM E514/E514M | (2014a) Standard Test Method for Water Penetration and Leakage Through Masonry |

1.2 SUBMITTALS

Contracting Officer's written approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Cold Weather Installation
Water-Repellant Admixture

SD-04 Samples

Concrete Masonry Units (CMU)
Anchors, Ties, and Bar Positioners
Joint Reinforcement

SD-05 Design Data

Pre-mixed Mortar

SD-06 Test Reports

Single-Wythe Masonry Wall Water Penetration Test

SD-07 Certificates

Concrete Masonry Units (CMU)
Anchors, Ties, and Bar Positioners
Joint Reinforcement
Certificates of Compliance
Admixtures for Grout

SD-08 Manufacturer's Instructions

Masonry Cement

## 1.3 DELIVERY, STORAGE, AND HANDLING

Materials shall be delivered, stored, handled, and protected to avoid chipping, breakage, and contact with soil or contaminating material. Store and prepare materials in already disturbed areas to minimize project site disturbance and size of project site.

### 1.3.1 Masonry Units

Cover and protect moisture-controlled concrete masonry units and cementitious materials from precipitation. Conform to all handling and storage requirements of ASTM C90. Mark prefabricated lintels on top sides to show either the lintel schedule number or the number and size of top and bottom bars.

### 1.3.2 Reinforcement, Anchors, and Ties

Steel reinforcing bars, coated anchors, ties, and joint reinforcement shall be stored above the ground. Steel reinforcing bars and uncoated ties shall be free of loose mill scale and rust.

1.3.3 Cementitious Materials, Sand and Aggregates

Cementitious and other packaged materials shall be delivered in unopened containers, plainly marked and labeled with manufacturers' names and brands. Cementitious material shall be stored in dry, weathertight enclosures or be completely covered. Cement shall be handled in a manner that will prevent the inclusion of foreign materials and damage by water or dampness. Store sand and aggregates in a manner to prevent contamination or segregation.

1.4 PROJECT/SITE CONDITIONS

Conform to ACI 530/530.1 for hot and cold weather masonry erection.

1.4.1 Hot Weather Installation

Take the following precautions if masonry is erected when the ambient air temperature is more than 99 degrees F in the shade and the relative humidity is less than 50 percent or the ambient air temperature exceeds 90 degrees F and the wind velocity is more than 8 mph. All masonry materials shall be shaded from direct sunlight; mortar beds shall be spread no more than 4 feet ahead of masonry; masonry units shall be set within one minute of spreading mortar; and after erection, masonry shall be protected from direct exposure to wind and sun for 48 hours.

1.4.2 Cold Weather Installation

Before erecting masonry when ambient temperature or mean daily air temperature falls below 40 degrees F or temperature of masonry units is below 40 degrees F, submit a written statement of proposed cold weather construction procedures for approval.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

The source of materials which will affect the appearance of the finished work shall not be changed after the work has started except with Contracting Officer's approval. Submit certificates of compliance stating that the materials meet the specified requirements.

2.2 CONCRETE MASONRY UNITS (CMU)

Submit samples and certificates as specified. Cement shall have a low alkali content and be of one brand. Units shall be of modular dimensions and air, water, or steam cured. Exposed surfaces of units shall be smooth and of uniform texture. Exterior concrete masonry units shall have water-repellant admixture added during manufacture.

a. Hollow Non-Load-Bearing Units: ASTM C129, made with lightweight or normal weight aggregate. Load-bearing units may be provided in lieu of non-load-bearing units.

### 2.2.1 Aggregates

Lightweight aggregates and blends of lightweight and heavier aggregates in proportions used in producing the units, shall comply with the following requirements when tested for stain-producing iron compounds in accordance with ASTM C641: by visual classification method, the iron stain deposited on the filter paper shall not exceed the "light stain" classification. Use industrial waste by-products (air-cooled slag, cinders, or bottom ash), ground waste glass and concrete, granulated slag, and expanded slag in aggregates. Slag shall comply with ASTM C989/C989M; Grade 80.

### 2.2.2 Kinds and Shapes

Units shall be modular in size and shall include closer, jamb, header, lintel, and bond beam units and special shapes and sizes to complete the work as indicated. Units used in exposed masonry surfaces in any one building shall have a uniform fine to medium texture and a uniform color.

#### 2.2.2.1 Architectural Units

Units shall have patterned face shell. Exterior face shell pattern shall be ground faced. Interior face to recieve paint finish. Units shall be integrally colored during manufacture. Color shall be as selected from standard manufacturer's selections. Patterned face shell shall be properly aligned in the completed wall.

## 2.3 MASONRY MORTAR

Mortar Type S shall conform to the proportion specification of ASTM C270 except Type S cement-lime mortar proportions shall be 1 part cement, 1/2 part lime and 4-1/2 parts aggregate. When masonry cement ASTM C91/C91M is used the maximum air content shall be limited to 12 percent and performance equal to cement-lime mortar shall be verified. Verification of masonry cement performance shall be based on ASTM C780 and ASTM C1072. Pointing mortar in showers and kitchens shall contain ammonium stearate, or aluminum tri-stearate, or calcium stearate in an amount equal to 3 percent by weight of cement used. Cement shall have a low alkali content and be of one brand. Aggregates shall be from one source.

### 2.3.1 Admixtures for Masonry Mortar

In cold weather, a non-chloride based accelerating admixture may be used subject to approval. Accelerating admixture shall be non-corrosive, shall contain less than 0.2 percent chlorides, and shall conform to ASTM C494/C494M, Type C. Submit the required certifications.

### 2.3.2 Hydrated Lime and Alternates

Hydrated lime shall conform to ASTM C207, Type S.

### 2.3.3 Cement

Portland cement shall conform to ASTM C150/C150M, Type I or III. Masonry cement shall conform to ASTM C91/C91M, Type S. Containers shall bear complete instructions for proportioning and mixing to obtain the required types of mortar. Incorporate to the maximum extent, without conflicting with other requirements of this section, up to 40 percent fly ash, up to 70 percent slag, up to 10 percent cenospheres, and up to 10 percent silica fume. When masonry cement is used, submit the manufacturer's printed instructions on proportions of water and aggregates and on mixing to obtain the type of mortar required. Additives shall conform to requirements in Section 03 30 00 CAST-IN-PLACE CONCRETE.

2.3.4 Pre-Mixed Mortar

Pre-mixed mortar shall conform to ASTM C1142, Type RS. Submit pre-mixed mortar composition.

2.3.5 Sand and Water

Sand shall conform to ASTM C144. Water shall be clean, potable, and free from substances which could adversely affect the mortar.

2.4 WATER-REPELLANT ADMIXTURE

Polymeric type formulated to reduce porosity and water penetration and water absorption of the mortar and masonry units required to provide for the exterior single-wythe masonry wall water penetration resistance indicated in Paragraph SINGLE-WYTHE MASONRY WALL WATER PENETRATION TEST.

2.5 GROUT AND READY-MIXED GROUT

Grout shall conform to ASTM C476, coarse. Cement used in grout shall have a low alkali content. Grout slump shall be between 8 and 10 inches. Minimum grout strength shall be 2000 psi in 28 days, as tested by ASTM C1019. Use grout subject to the limitations of Table III. Do not change proportions and do not use materials with different physical or chemical characteristics in grout for the work unless additional evidence is furnished that the grout meets the specified requirements. Ready-Mixed grout shall conform to ASTM C94/C94M.

2.5.1 Admixtures for Grout

In cold weather, a non-chloride based accelerating admixture may be used subject to approval; accelerating admixture shall be non-corrosive, shall contain less than 0.2 percent chlorides, and shall conform to ASTM C494/C494M, Type C. In general, air-entrainment, anti-freeze or chloride admixtures shall not be used except as approved by the Contracting Officer. Submit required certifications.

2.5.2 Grout Barriers

Grout barriers for vertical cores shall consist of fine mesh wire, fiberglass, or expanded metal.

## 2.6 ANCHORS, TIES, AND BAR POSITIONERS

Anchors and ties shall be fabricated without drips or crimps and shall be zinc-coated in accordance with ASTM A153/A153M, Class B-2. Steel wire used for anchors and ties shall be fabricated from steel wire conforming to ASTM A1064/A1064M. Wire ties or anchors in exterior walls shall conform to ASTM A641/A641M. Joint reinforcement in interior walls, and in exterior or interior walls exposed to moist environment shall conform to ASTM A641/A641M; coordinate with paragraph JOINT REINFORCEMENT below. Anchors and ties shall be sized to provide a minimum of 5/8 inch mortar cover from either face. Submit two anchors, ties and bar positioners of each type used, as samples.

### 2.6.1 Adjustable Anchors

Adjustable anchors shall be 3/16 inch diameter steel wire, triangular-shaped. Anchors attached to steel shall be 5/16 inch diameter steel bars placed to provide 1/16 inch play between flexible anchors and structural steel members. Spacers shall be welded to rods and columns. Equivalent welded-on steel anchor rods or shapes standard with the flexible-anchor manufacturer may be furnished when approved. Welds shall be cleaned and given one coat of zinc-rich touch up paint.

### 2.6.2 Bar Positioners

Bar positioners, used to prevent displacement of reinforcing bars during the course of construction, shall be factory fabricated from 9 gauge steel wire or equivalent, and coated with a hot-dip galvanized finish. Not more than one wire shall cross the cell. Telescoping bar positioner shall be manufactured from AISI 1065 spring steel and coated in accordance with ASTM B633.

## 2.7 JOINT REINFORCEMENT

Joint reinforcement shall be factory fabricated from steel wire conforming to ASTM A1064/A1064M, welded construction. Tack welding will not be acceptable in reinforcement used for wall ties. Wire shall have zinc coating conforming to ASTM A153/A153M, Class B-2. All wires shall be a minimum of 9 gauge. Reinforcement shall be ladder type design, having one longitudinal wire in the mortar bed of each face shell for hollow units and one wire for solid units. Joint reinforcement shall be placed a minimum of 5/8 inch cover from either face. The distance between crosswires shall not exceed 16 inches. Joint reinforcement for straight runs shall be furnished in flat sections not less than 10 feet long. Joint reinforcement shall be provided with factory formed corners and intersections.

## 2.8 REINFORCING STEEL BARS AND RODS

Reinforcing steel bars and rods shall conform to ASTM A615/A615M, Grade 60.

## 2.9 THROUGH WALL FLASHING

Provide Through Wall Flashing as specified in Section 07 60 00 FLASHING AND SHEET METAL. Provide one of the following types.

2.9.1 Copper or Stainless Steel Flashing

Copper, ASTM B370, minimum 16 ounce weight; stainless steel, ASTM A167, Type 301, 302, 304, or 316, 0.015 inch thick, No. 2D finish. Provide with factory-fabricated deformations that mechanically bond flashing against horizontal movement in all directions. Deformations shall consist of dimples, diagonal corrugations, or a combination of dimples and transverse corrugations.

PART 3 EXECUTION

3.1 PREPARATION

Prior to start of work, masonry inspector shall verify the applicable conditions as set forth in ACI 530/530.1, inspection. The Contracting Officer's Representativewill serve as inspector or will select a masonry inspector.

3.1.1 Protection

Ice or snow formed on the masonry bed shall be thawed by the application of heat. Heat shall be applied carefully until the top surface of the masonry is dry to the touch. Sections of masonry deemed frozen and damaged shall be removed before continuing construction of those sections.

3.1.1.1 Air Temperature 40 to 32 Degrees F

Heat sand or mixing water to produce mortar temperatures between 40 and 120 degrees F

3.1.1.2 Air Temperature 32 to 25 Degrees F

Heat sand and mixing water to produce mortar temperatures between 40 and 120 degrees F. Maintain temperature of mortar on boards above freezing.

3.1.1.3 Air Temperature 25 to 20 Degrees F

Heat sand and mixing water to provide mortar temperatures between 40 and 120 degrees F. Maintain temperature of mortar on boards above freezing. Use sources of heat on both sides of walls under construction. Employ windbreaks when wind is in excess of 15 mph.

3.1.1.4 Air Temperature 20 Degrees F and Below

Heat sand and mixing water to provide mortar temperatures between 40 and 120 degrees F. Provide enclosure and auxiliary heat to maintain air temperature above 32 degrees F. Temperature of units when laid must not be less than 20 degrees F.

3.1.2 Completed Masonry and Masonry Not Being Worked On

3.1.2.1 Mean Daily Air Temperature 40 to 32 Degrees F

Protect masonry from rain or snow for 24 hours by covering with weather-resistive membrane.

3.1.2.2 Mean Daily Air Temperature 32 to 25 Degrees F

Completely cover masonry with weather-resistant membrane for 24 hours.

3.1.2.3 Mean Daily Air Temperature 25 to 20 Degrees F

Completey cover masonry with insulating blankets or equally protected for 24 hours.

3.1.2.4 Mean Daily Temperature 20 Degrees F and Below

Maintain masonry temperature above 32 degrees F for 24 hours by enclosure and supplementary heat, by electric heating blankets, infrared heat lamps, or other approved methods.

3.1.3 Stains

Protect exposed surfaces from mortar and other stains. When mortar joints are tooled, remove mortar from exposed surfaces with fiber brushes and wooden paddles. Protect base of walls from splash stains by covering adjacent ground with sand, sawdust, or polyethylene.

3.1.4 Loads

Do not apply uniform loads for at least 12 hours or concentrated loads for at least 72 hours after masonry is constructed. Provide temporary bracing as required.

3.1.5 Surfaces

Clean surfaces on which masonry is to be placed of laitance, dust, dirt, oil, organic matter, or other foreign materials and slightly roughen to provide a surface texture with a depth of at least 1/8 inch. Sandblast, if necessary, to remove laitance from pores and to expose the aggregate.

3.2 LAYING MASONRY UNITS

a. Coordinate masonry work with the work of other trades to accommodate built-in items and to avoid cutting and patching. Masonry units shall be laid in running bond pattern. Facing courses shall be level with back-up courses, unless the use of adjustable ties has been approved in which case the tolerances shall be plus or minus 1/2 inch. Each unit shall be adjusted to its final position while mortar is still soft and plastic.

b. Units that have been disturbed after the mortar has stiffened shall be removed, cleaned, and relaid with fresh mortar. Air spaces, cavities, chases, expansion joints, and spaces to be

grouted shall be kept free from mortar and other debris. Units used in exposed masonry surfaces shall be selected from those having the least amount of chipped edges or other imperfections detracting from the appearance of the finished work. Vertical joints shall be kept plumb.

c. Units being laid and surfaces to receive units shall be free of water film and frost. Solid units shall be laid in a nonfurrowed full bed of mortar. Mortar for veneer wythes shall be beveled and sloped toward the center of the wythe from the cavity side. Units shall be shoved into place so that the vertical joints are tight. Vertical joints of brick and the vertical face shells of concrete masonry units, except where indicated at control, expansion, and isolation joints, shall be completely filled with mortar. Mortar will be permitted to protrude up to 1/2 inch into the space or cells to be grouted. Means shall be provided to prevent mortar from dropping into the space below.

3.2.1 Forms and Shores

Provide bracing and scaffolding as required. Design bracing to resist wind pressure as required by local codes. Forms and shores shall be sufficiently rigid to prevent deflections which may result in cracking or other damage to supported masonry and sufficiently tight to prevent leakage of mortar and grout. Supporting forms and shores shall not be removed in less than 10 days.

3.2.2 Reinforced Concrete Masonry Units Walls

Where vertical reinforcement occurs, fill cores solid with grout. Lay units in such a manner as to preserve the unobstructed vertical continuity of cores to be filled. Embed the adjacent webs in mortar to prevent leakage of grout. Remove mortar fins protruding from joints before placing grout. Minimum clear dimensions of vertical cores shall be 2 by 3 inches. Position reinforcing accurately as indicated before placing grout. As masonry work progresses, secure vertical reinforcing in place at vertical intervals not to exceed 160 bar diameters. Use puddling rod or vibrator to consolidate the grout. Minimum clear distance between masonry and vertical reinforcement shall be not less than 1/2 inch. Unless indicated or specified otherwise, form splices by lapping bars not less than 40 bar diameters and wire tying them together.

3.2.3 Concrete Masonry Units

Units in piers, pilasters, columns, starting courses on footings, solid foundation walls, lintels, and beams, and where cells are to be filled with grout shall be full bedded in mortar under both face shells and webs. Other units shall be full bedded under both face shells. Head joints shall be filled solidly with mortar for a distance in from the face of the unit not less than the thickness of the face shell. Foundation walls below grade shall be grouted solid. Jamb units shall be of the shapes and sizes to conform with wall units. Solid units may be incorporated in the masonry work where necessary to fill out at corners, gable slopes, and elsewhere as approved. Double walls shall be stiffened at wall-mounted plumbing fixtures by use of strap anchors, two above each fixture and two below each fixture, located to avoid pipe runs, and extending from center to center of the double wall. Walls and partitions shall be adequately reinforced for support of wall-hung plumbing fixtures when chair carriers are not specified.

### 3.2.4 Tolerances

Lay masonry plumb, true to line, with courses level. Keep bond pattern plumb throughout. Square corners unless noted otherwise.

### 3.2.5 Cutting and Fitting

Full units of the proper size shall be used wherever possible, in lieu of cut units. Cutting and fitting, including that required to accommodate the work of others, shall be done by masonry mechanics using power masonry saws. Concrete masonry units may be wet or dry cut. Wet cut units, before being placed in the work, shall be dried to the same surface-dry appearance as uncut units being laid in the wall. Cut edges shall be clean, true and sharp. Openings in the masonry shall be made carefully so that wall plates, cover plates or escutcheons required by the installation will completely conceal the openings and will have bottoms parallel with the masonry bed joints. Reinforced masonry lintels shall be provided above openings over 12 inches wide for pipes, ducts, cable trays, and other wall penetrations, unless steel sleeves are used.

### 3.2.6 Jointing

Joints shall be tooled when the mortar is thumbprint hard. Horizontal joints shall be tooled last. Joints shall be brushed to remove all loose and excess mortar. Mortar joints shall be finished as follows:

#### 3.2.6.1 Tooled Joints

Joints in exposed exterior and interior masonry surfaces shall be tooled slightly concave. Joints shall be tooled with a jointer slightly larger than the joint width so that complete contact is made along the edges of the unit. Tooling shall be performed so that the mortar is compressed and the joint surface is sealed. Jointer of sufficient length shall be used to obtain a straight and true mortar joint.

#### 3.2.6.2 Door and Window Frame Joints

On the exposed interior side of exterior frames, joints between frames and abutting masonry walls shall be raked to a depth of 3/8 inch. On the exterior side of exterior frames, joints between frames and abutting masonry walls shall be raked to a depth of 3/8 inch.

### 3.2.7 Joint Widths

Joint widths shall be as follows:

#### 3.2.7.1 Concrete Masonry Units

Concrete masonry units shall have 3/8 inch joints.

### 3.2.8 Embedded Items

Fill spaces around built-in items with mortar. Point openings around flush-mount electrical outlet boxes in wet locations with mortar. Embed anchors, ties, wall plugs, accessories, flashing, pipe sleeves and other items required to be built-in as the masonry work progresses. Fully embed anchors, ties and joint reinforcement in the mortar. Fill cells receiving anchor bolts and cells of the first course below bearing plates with grout.

### 3.2.9 Unfinished Work

Step back unfinished work for joining with new work. Toothing may be resorted to only when specifically approved. Remove loose mortar and thoroughly clean the exposed joints before laying new work.

### 3.2.10 Masonry Wall Intersections

Masonry bond each course at corners and elsewhere as shown. Masonry walls shall be anchored or tied together at corners and intersections with bond beam reinforcement and prefabricated corner or tee pieces of joint reinforcement as shown.

## 3.3 MORTAR MIX

Mix mortar in a mechanically operated mortar mixer for at least 3 minutes, but not more than 5 minutes. Measure ingredients for mortar by volume. Ingredients not in containers, such as sand, shall be accurately measured by the use of measuring boxes. Mix water with the dry ingredients in sufficient amount to provide a workable mixture which will adhere to the vertical surfaces of masonry units. Retemper mortar that has stiffened because of loss of water through evaporation by adding water to restore the proper consistency and workability. Discard mortar that has reached its initial set or that has not been used within 2.5 hours after mixing.

## 3.4 REINFORCING STEEL

Clean reinforcement of loose, flaky rust, scale, grease, mortar, grout, or other coating which might destroy or reduce its bond prior to placing grout. Bars with kinks or bends not shown on the drawings shall not be used. Reinforcement shall be placed prior to grouting. Unless otherwise indicated, vertical wall reinforcement shall extend to within 2 inches of tops of walls.

### 3.4.1 Positioning Bars

Vertical bars shall be accurately placed within the cells at the positions indicated on the drawings. A minimum clearance of 1/2 inch shall be maintained between the bars and masonry units. Minimum clearance between parallel bars shall be one diameter of the reinforcement. Vertical reinforcing may be held in place using bar positioners located near the ends of each bar and at intermediate intervals of not more than 160 diameters of the reinforcement. Column and pilaster ties shall be wired in position around the vertical steel. Ties shall be in contact with the vertical reinforcement and shall not be placed in horizontal bed joints.

### 3.4.2 Splices

Bars shall be lapped a minimum of 40 diameters of the reinforcement. Welded or mechanical connections shall develop at least 125 percent of the specified yield strength of the reinforcement.

## 3.5 JOINT REINFORCEMENT INSTALLATION

Install joint reinforcement at 16 inches on center or as indicated. Reinforcement shall be lapped not less than 6 inches. Install prefabricated sections at corners and wall intersections. Place the longitudinal wires of joint reinforcement to provide not less than 5/8 inch cover to either face of the unit.

## 3.6 PLACING GROUT

Fill cells containing reinforcing bars with grout. Hollow masonry units in walls or partitions supporting plumbing, heating, or other mechanical fixtures, voids at door and window jambs, and other indicated spaces shall be filled solid with grout. Cells under lintel bearings on each side of openings shall be filled solid with grout for full height of openings. Walls below grade, lintels, and bond beams shall be filled solid with grout. Units other than open end units may require grouting each course to preclude voids in the units. Grout not in place within 1-1/2 hours after water is first added to the batch shall be discarded. Sufficient time shall be allowed between grout lifts to preclude displacement or cracking of face shells of masonry units. If blowouts, flowouts, misalignment, or cracking of face shells should occur during construction, the wall shall be torn down and rebuilt.

### 3.6.1 Horizontal Grout Barriers

Embed grout barriers in mortar below cells of hollow units receiving grout.

### 3.6.2 Grouting Equipment

#### 3.6.2.1 Grout Pumps

Pumping through aluminum tubes will not be permitted. Operate pumps to produce a continuous stream of grout without air pockets, segregation, or contamination. Upon completion of each day's pumping, remove waste materials and debris from the equipment, and dispose of outside the masonry.

#### 3.6.2.2 Vibrators

Internal vibrators shall maintain a speed of not less than 5,000 impulses per minute when submerged in the grout. Maintain at least one spare vibrator at the site at all times. Apply vibrators at uniformly spaced points not further apart than the visible effectiveness of the

machine. Limit duration of vibration to time necessary to produce satisfactory consolidation without causing segregation.

### 3.6.3 Grout Placement

Lay masonry to the top of a pour before placing grout. Do no place grout in two-wythe solid unit masonry cavity until mortar joints have set for at least 3 days during hot weather and 5 days during cold damp weather. Grout shall not be placed in hollow unit masonry until mortar joints have set for at least 24 hours. Grout shall be placed using a hand bucket, concrete hopper, or grout pump to completely fill the grout spaces without segregation of the aggregates. Vibrators shall not be inserted into lower pours that are in a semi-solidified state. The height of grout pours and type of grout used shall be limited by the dimensions of grout spaces as indicated in Table III. Low-lift grout methods may be used on pours up to and including 5 feet in height. High-lift grout methods shall be used on pours exceeding 5 feet in height.

## 3.7 BOND BEAMS

Bond beams shall be filled with grout and reinforced as indicated on the drawings. Grout barriers shall be installed under bond beam units to retain the grout as required. Reinforcement shall be continuous, including around corners, except through control joints or expansion joints, unless otherwise indicated on the drawings. Where splices are required for continuity, reinforcement shall be lapped 48 bar diameters. A minimum clearance of 1/2 inch shall be maintained between reinforcement and interior faces of units.

## 3.8 LINTELS

### 3.8.1 Masonry Lintels

Construct masonry lintels with lintel units filled solid with grout in all courses and reinforced with a minimum of two No. 4 bars in the bottom course unless otherwise indicated on the drawings. Lintel reinforcement shall extend beyond each side of masonry opening 40 bar diameters or 24 inches, whichever is greater. Reinforcing bars shall be supported in place prior to grouting and shall be located 1/2 inch above the bottom inside surface of the lintel unit.

## 3.9 ANCHORAGE TO CONCRETE AND STRUCTURAL STEEL

### 3.9.1 Anchorage to Structural Steel

Masonry shall be anchored to vertical structural steel framing with adjustable steel wire anchors spaced not over 16 inches on centers vertically, and if applicable, not over 24 inches on centers horizontally.

## 3.10 POINTING AND CLEANING

After mortar joints have attained their initial set, but prior to hardening, completely remove mortar and grout daubs or splashings from masonry-unit surfaces that will be exposed or painted.

Before completion of the work, defects in joints of masonry to be exposed or painted shall be raked out as necessary, filled with mortar, and tooled to match existing joints. Immediately after grout work is completed, scum and stains which have percolated through the masonry work shall be removed using a high pressure stream of water and a stiff bristled brush. Masonry surfaces shall not be cleaned, other than removing excess surface mortar, until mortar in joints has hardened. Masonry surfaces shall be left clean, free of mortar daubs, dirt, stain, and discoloration, including scum from cleaning operations, and with tight mortar joints throughout. Metal tools and metal brushes shall not be used for cleaning.

### 3.10.1 Dry-Brushing

Exposed concrete masonry unit shall be dry-brushed at the end of each day's work and after any required pointing, using stiff-fiber bristled brushes.

## 3.11 PROTECTION

Protect facing materials against staining. Cover top of walls with nonstaining waterproof covering or membrane when work is not in progress. Covering of the top of the unfinished walls shall continue until the wall is waterproofed with a complete roof or parapet system. Covering shall extend a minimum of 2 feet down on each side of the wall and shall be held securely in place. Before starting or resuming, top surface of masonry in place shall be cleaned of loose mortar and foreign material.

## 3.12 TEST REPORTS

### 3.12.1 Single-Wythe Masonry Wall Water Penetration Test

Prior to start of field construction of the single-wythe masonry wall, perform masonry wall water penetration test on mock-up wall assemblies consisting of the identical design, materials, mix, and construction methods as the actual wall construction and in accordance with ASTM E514/E514M. Prepare a minimum of three specimens and cure for minimum 28 days prior to testing. Construct panels by the same methods, processes, and applications to be used on the project's construction site. The spray test duration shall be 6 hours for each specimen. No water shall be visible on back of test panels during the test and any areas of dampness on the backside of the test panels shall not exceed 25 percent of the wall area. Dampness is defined as any area of surface darkening or discoloration due to moisture penetration or accumulation below the observed surface. Construct additional test panels for each failed test performed until three test panels pass the test. Factors that can affect test performance include materials, mixing, and quality of application and workmanship. Materials, mixing, and methods adjustments may be necessary in order to provide construction that passes the water penetration test. Document and record the test specimen construction materials and application and provide written test report in accordance with ASTM E514/E514M, supplemented by a detailed discussion of the specifics of test panel construction, application methods and processes used, quality of construction, and any variances or deviations that may have occurred between test panels during test panel construction. For failed test panels, identify in the supplemental report any variances, deficiencies or flaws that contributed to test panel failure and itemize the precautions to be taken

in field construction of the masonry wall to prevent similar deficiencies and assure the wall construction replicates test panel conditions that pass the water penetration test. Submit the complete, certified test report, including supplemental report, to the Contracting Officer prior to start of single-wythe masonry wall construction. Significant changes to materials, proportions, or construction techniques from those used in the passing water penetration test are grounds for performing new tests, at the discretion of the Contracting Officer.

-- End of Section 04 20 00 --

SECTION 05 12 00
STRUCTURAL STEEL

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

| | |
|---|---|
| AISC 303 | (2010) Code of Standard Practice for Steel Buildings and Bridges |
| AISC 325 | (2011) Steel Construction Manual |
| AISC 326 | (2009) Detailing for Steel Construction |
| AISC 360 | (2010) Specification for Structural Steel Buildings |
| AISC DESIGN GUIDE 10 | (1997) Erection Bracing of Low-Rise Structural Steel Buildings |

AMERICAN WELDING SOCIETY (AWS)

| | |
|---|---|
| AWS A2.4 | (2012) Standard Symbols for Welding, Brazing and Nondestructive Examination |
| AWS D1.1/D1.1M | (2010; Errata 2011) Structural Welding Code - Steel |

ASME INTERNATIONAL (ASME)

| | |
|---|---|
| ASME B46.1 | (2009) Surface Texture, Surface Roughness, Waviness and Lay |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A123/A123M | (2013) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products |
| ASTM A325 | (2010; E 2013) Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength |
| ASTM A36/A36M | (2012) Standard Specification for Carbon Structural Steel |

| | |
|---|---|
| ASTM A490 | (2012) Standard Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength |
| ASTM A500/A500M | (2013) Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes |
| ASTM A563 | (2007a; R2014) Standard Specification for Carbon and Alloy Steel Nuts |
| ASTM A6/A6M | (2014) Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling |
| ASTM A992/A992M | (2011) Standard Specification for Structural Steel Shapes |
| ASTM C1107/C1107M | (2014) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink) |
| ASTM C827/C827M | (2010) Change in Height at Early Ages of Cylindrical Specimens from Cementitious Mixtures |
| ASTM F1554 | (2007a; E 2011) Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength |
| ASTM F2329 | (2013) Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners |
| ASTM F436 | (2011) Hardened Steel Washers |
| ASTM F844 | (2007a; R 2013) Washers, Steel, Plain (Flat), Unhardened for General Use |
| ASTM F959 | (2013) Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners |

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

| | |
|---|---|
| SSPC Paint 20 | (2002; E 2004) Zinc-Rich Primers (Type I, Inorganic, and Type II, Organic) |
| SSPC Paint 29 | (2002; E 2004) Zinc Dust Sacrificial Primer, Performance-Based |

| | |
|---|---|
| SSPC SP 3 | (1982; E 2004) Power Tool Cleaning |
| SSPC SP 6/NACE No.3 | (2007) Commercial Blast Cleaning |

1.2 SUBMITTALS

Contracting Officer's written approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Erection drawings

SD-02 Shop Drawings

Fabrication drawings including description of connections

SD-03 Product Data

Shop primer

Direct Tension Indicator Washers

SD-06 Test Reports

Bolts, nuts, and washers

SD-07 Certificates

Steel

Bolts, nuts, and washers

AISC fabrication plant quality certification

Welding procedures and qualifications

1.3 AISC QUALITY CERTIFICATION

Work must be fabricated in an AISC Certified Fabrication Plant, Category Std. Submit AISC fabrication plant quality certification.

1.4 QUALITY ASSURANCE

1.4.1 Preconstruction Submittals

#### 1.4.1.1 Erection Drawings

Submit for record purposes. Indicate the sequence of erection, temporary shoring and bracing. The erection drawings must conform to AISC 303. Erection drawings must be reviewed, stamped and sealed by a registered professional engineer.

### 1.4.2 Fabrication Drawing Requirements

Submit fabrication drawings for approval prior to fabrication. Prepare in accordance with AISC 326 and AISC 325. Fabrication drawings must not be reproductions of contract drawings. Sign and seal fabrication drawings by a registered professional engineer. Include complete information for the fabrication and erection of the structure's components, including the location, type, and size of bolts, welds, member sizes and lengths, connection details, blocks, copes, and cuts. Use AWS A2.4 standard welding symbols. Any deviations from the details shown on the contract drawings must be clearly highlighted on the fabrication drawings. Explain the reasons for any deviations from the contract drawings.

### 1.4.3 Certifications

#### 1.4.3.1 Welding Procedures and Qualifications

Prior to welding, submit certification for each welder stating the type of welding and positions qualified for, the code and procedure qualified under, date qualified, and the firm and individual certifying the qualification tests.

Conform to all requirements specified in AWS D1.1/D1.1M.

## PART 2 PRODUCTS

### 2.1 SYSTEM DESCRIPTION

Provide the structural steel system, including galvanizing, complete and ready for use. Structural steel systems including design, materials, installation, workmanship, fabrication, assembly, erection, inspection, quality control, and testing must be provided in accordance with AISC 360.

### 2.2 STEEL

#### 2.2.1 Structural Steel

Wide flange and WT shapes, ASTM A992/A992M. Angles, Channels and Plates, ASTM A36/A36M. Tube Steel, ASTM A500/A500M.

### 2.3 BOLTS, NUTS, AND WASHERS

Submit the certified manufacturer's mill reports which clearly show the applicable ASTM mechanical and chemical requirements together with the actual test results for the supplied fasteners.

2.3.1 High-Strength Bolts

2.3.1.1 Bolts

ASTM A325, Type 1 ASTM A490, Type 1 or 2.

2.3.1.2 Nuts

ASTM A563, Grade and Style as specified in the applicable ASTM bolt standard.

2.3.1.3 Direct Tension Indicator Washers

ASTM F959.

2.3.1.4 Washers

ASTM F436, plain carbon steel.

2.3.2 Foundation Anchorage

2.3.2.1 Anchor Rods

ASTM F1554 Gr 36.

2.3.2.2 Anchor Nuts

ASTM A563, Grade A, hex style.

2.3.2.3 Anchor Washers

ASTM F844.

2.3.2.4 Anchor Plate Washers

ASTM A36/A36M.

2.4 STRUCTURAL STEEL ACCESSORIES

2.4.1 Welding Electrodes and Rods

AWS D1.1/D1.1M.

2.4.2 Non-Shrink Grout

ASTM C1107/C1107M, with no ASTM C827/C827M shrinkage.

2.5 GALVANIZING

ASTM F2329 for threaded parts or ASTM A123/A123M for structural steel members, as applicable, unless specified otherwise galvanize after fabrication where practicable.

2.6 FABRICATION

Fabrication must be in accordance with the applicable provisions of AISC 325. Fabrication and assembly must be done in the shop to the greatest extent possible.

Compression joints depending on contact bearing must have a surface roughness not in excess of 500 micro inch as determined by ASME B46.1, and ends must be square within the tolerances for milled ends specified in ASTM A6/A6M.

Shop splices of members between field splices will be permitted only where indicated on the Contract Drawings. Splices not indicated require the approval of the Contracting Officer's Representative.

2.6.1 Shop Primer

SSPC Paint 20 or SSPC Paint 29, (zinc rich primer).

2.6.1.1 Cleaning

SSPC SP 6/NACE No.3, except steel exposed in spaces above ceilings, attic spaces, furred spaces, and chases that will be hidden to view in finished construction may be cleaned to SSPC SP 3 when recommended by the shop primer manufacturer. Maintain steel surfaces free from rust, dirt, oil, grease, and other contaminants through final assembly.

2.6.2 Surface Finishes

ASME B46.1 maximum surface roughness of 125 for pin, pinholes, and sliding bearings, unless indicated otherwise.

2.7 DRAINAGE HOLES

Adequate drainage holes must be drilled to eliminate water traps. Hole diameter must be 1/2 inch and location must be indicated on the detail drawings. Hole size and location must not affect the structural integrity.

PART 3 EXECUTION

## 3.1 ERECTION

A. Erection of structural steel, except as indicated in item b. below, must be in accordance with the applicable provisions of AISC 325.

B. For low-rise structural steel buildings (60 feet tall or less and a maximum of 2 stories), the structure must be erected in accordance with AISC DESIGN GUIDE 10.

C. After final positioning of steel members, provide full bearing under base plates and bearing plates using nonshrink grout. Place nonshrink grout in accordance with the manufacturer's instructions.

### 3.1.1 STORAGE

Material must be stored out of contact with the ground in such manner and location as will minimize deterioration.

## 3.2 CONNECTIONS

Except as modified in this section, connections not detailed must be designed in accordance with AISC 360. Build connections into existing work. Do not tighten anchor bolts set in concrete with impact torque wrenches. Holes must not be cut or enlarged by burning. Bolts, nuts, and washers must be clean of dirt and rust, and lubricated immediately prior to installation.

### 3.2.1 High-Strength Bolts

Provide direct tension indicator washers in all ASTM A325 bolted connections. Bolts must be installed in connection holes and initially brought to a snug tight fit. After the initial tightening procedure, bolts must then be fully tensioned, progressing from the most rigid part of a connection to the free edges.

## 3.3 WELDING

Welding must be in accordance with AWS D1.1/D1.1M. Provide AWS D1.1/D1.1M qualified welders, welding operators, and tackers.

Develop and submit the Welding Procedure Specifications (WPS) for all welding, including welding done using prequalified procedures. Prequalified procedures may be submitted for information only; however, procedures that are not prequalified must be submitted for approval.

## 3.4 SHOP PRIMER REPAIR

Repair shop primer in accordance with the paint manufacturer's recommendation for surfaces damaged by handling, transporting, cutting, welding, or bolting.

### 3.4.1 Field Priming

Steel exposed to the weather, or located in building areas without HVAC for control of relative humidity must be field primed. After erection, the field bolt heads and nuts, field welds, and any abrasions in the shop coat must be cleaned and primed with paint of the same quality as that used for the shop coat.

## 3.5 FIELD QUALITY CONTROL

### 3.5.1 Welds

#### 3.5.1.1 Visual Inspection

AWS D1.1/D1.1M. Furnish the services of AWS-certified welding inspectors for fabrication and erection inspection and testing and verification inspections.

-- End of Section 05 12 00 --

SECTION 05 40 00
COLD-FORMED METAL FRAMING

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN IRON AND STEEL INSTITUTE (AISI)

| | |
|---|---|
| AISI S100 | (2012) North American Specification for the Design of Cold-Formed Steel Structural Members |
| AISI S200 | (2007) North American Standard for Cold-Formed Steel Framing - General Provision |
| AISI S201 | (2007) North American Standard for Cold-Formed Steel Framing - Product Data |
| AISI S202 | (2011) Code of Standard Practice for Cold-formed Steel Structural Framing |
| AISI S211 | (2007) North American Standard for Cold-Formed Steel Framing - Wall Stud Design |
| AISI S212 | (2007) North American Standard for Cold-Formed Steel Framing - Header Design |
| AISI S213 | (2007; Suppl 1 2009) North American Standard for Cold-Formed Steel Framing - Lateral Design |
| AISI SG02-KIT | (2001; Supp 1 2004) North American Specification for the Design of Cold-Formed Steel Structural Members |
| AISI SG03-3 | (2002; Suppl 2001-2004; R 2008) Cold-Formed Steel Design Manual Set |

AMERICAN WELDING SOCIETY (AWS)

| | |
|---|---|
| AWS D1.1/D1.1M | (2010; Errata 2011) Structural Welding Code - Steel |
| AWS D1.3/D1.3M | (2008; Errata 2008) Structural Welding Code - Sheet Steel |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A1003/A1003M | (2013b) Standard Specification for Steel Sheet, Carbon, Metallic- and Nonmetallic-Coated for Cold-Formed Framing Members |
| ASTM A123/A123M | (2013) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products |
| ASTM A153/A153M | (2009) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware |
| ASTM A370 | (2014) Standard Test Methods and Definitions for Mechanical Testing of Steel Products |
| ASTM A653/A653M | (2013) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process |
| ASTM C1007 | (2011a) Standard Specification for Installation of Load Bearing (Transverse and Axial) Steel Studs and Related Accessories |
| ASTM C1513 | (2013) Standard Specification for Steel Tapping Screws for Cold-Formed Steel Framing Connections |
| ASTM C955 | (2011c) Load-Bearing (Transverse and Axial) Steel Studs, Runners (Tracks), and Bracing or Bridging for Screw Application of Gypsum Panel Products and Metal Plaster Bases |
| ASTM E119 | (2014) Standard Test Methods for Fire Tests of Building Construction and Materials |
| ASTM E329 | (2014a) Standard Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction |
| ASTM F1941 | (2010) Standard Specification for Electrodeposited Coatings on Threaded Fasteners (Unified Inch Screw Threads (UN/UNR)) |
| ASTM F1941M | (2007) Standard Specification for Electrodeposited Coatings on Threaded Fasteners (Metric) |

1.2 SUBMITTALS

Contracting Officer's written approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Framing Components

a. Cross sections, plans, and/or elevations showing component types and locations for each framing application; including shop coatings and material thicknesses for each framing component.

b. Connection details showing fastener type, quantity, location, and other information to assure proper installation.

c. Drawings depicting panel configuration, dimensions, components, locations, and construction sequence if the Contractor elects to install prefabricated/prefinished frames.

SD-03 Product Data

Steel joists, bridging and accessories

SD-05 Design Data

Metal framing calculations

SD-07 Certificates

Load-bearing cold-formed metal framing

Mill certificates or test reports from independent testing agency, qualified in accordance with ASTM E329, showing that the steel sheet used in the manufacture of each cold-formed component complies with the minimum yield strengths and uncoated steel thickness specified. Test reports shall be based on the results of three coupon tests in accordance with ASTM A370.

Welds

Certified copies of welder qualifications test records showing qualification in accordance with AWS D1.3/D1.3M.

## 1.3 DELIVERY, STORAGE, AND HANDLING

Deliver materials to job site and store in adequately ventilated, dry locations. Storage area shall permit easy access for inspection and handling. If necessary to store materials outside, stack off

the ground, support on a level platform, and protect from the weather as approved. Handle materials to prevent damage. Finish of the framing members shall be maintained at all times, using an approved high zinc dust content, galvanizing repair paint whenever necessary to prevent the formation of rust. Replace damaged items with new, as directed by the Contracting Officer. Steel framing and related accessories shall be stored and handled in accordance with the AISI S202, "Code of Standard Practice for Cold-Formed Steel Structural Framing".

## 1.4 LOAD-BEARING COLD-FORMED METAL FRAMING

Include bracing, fastenings, and other accessories necessary for complete installation. Framing members shall have the structural properties indicated. Where physical structural properties are not indicated, they shall be as necessary to withstand all imposed loads. Design framing in accordance with AISI SG03-3.

## 1.5 MAXIMUM DEFLECTION

a. Floor Joists:

L/360 - Live load only
L/240 - Total load

## 1.6 QUALITY ASSURANCE

a. Engineering Responsibility: Preparation of Shop Drawings, design calculations, and other structural data by a qualified professional engineer.

b. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of cold-formed metal framing that are similar to those indicated for this project in material, design, and extent.

c. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM E329 for testing indicated.

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

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

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel".

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

f. Fire-Test-Response Characteristics: Where indicated, provide cold-formed metal framing identical to that of assemblies tested for fire resistance per ASTM E119 by, and displaying a classification label from, a testing and inspecting agency acceptable to authorities having jurisdiction.

g. AISI Specifications and Standards: Comply with:

1. AISI S100, "North American Specification for the Design of Cold-Formed Steel Structural Members".

2. AISI S200, "North American Standard for Cold-Formed Steel Framing - General Provision".

3. AISI S201, "North American Standard for Cold-Formed Steel Framing - Product Data".

4. AISI S202, "Code of Standard Practice for Cold-Formed Steel Structural Framing".

5. AISI S211, "North American Standard for Cold-Formed Steel Framing - Wall Stud Design".

6. AISI S212, "North American Standard for Cold-Formed Steel Framing - Header Design".

7. AISI S213, "North American Standard for Cold-Formed Steel Framing - Lateral Design".

1.6.1 Drawing Requirements

Submit framing components to show sizes, thicknesses, layout, material designations, methods of installation, and accessories.

1.6.2 Design Data Required

Submit metal framing calculations to verify sizes, gages, and spacing of members and connections. Show methods and practices used in installation.

PART 2 PRODUCTS

2.1 STEEL JOISTS, BRIDGING AND ACCESSORIES

Framing components shall comply with ASTM C955 and the following:

a. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

b. Steel Sheet: ASTM A1003/A1003M, Structural Grade, Type H, metallic coated, of grade and coating weight as follows:

1. Grade: As required by structural performance.

2. Coating: G90 (Z275).

2.1.1 Joists of 16 Gage (0.0538 Inch) and Heavier

Galvanized steel, ASTM A653/A653M and ASTM A1003/A1003M, SS Grade 50, G90.

2.2 MARKINGS

Studs and track shall have product markings stamped on the web of the section. The markings shall be repeated throughout the length of the member at a maximum spacing of 4 feet on center and shall be legible and easily read. The product marking shall include the following:

a. An ICC number.

b. Manufacturer's identification.

c. Minimum delivered uncoated steel thickness.

d. Protective coating designator.

e. Minimum yield strength.

2.3 CONNECTIONS

Screws for steel-to-steel connections shall be self-drilling, tapping screws in compliance with ASTM C1513 of the type, size and location as shown on the drawings. Electroplated screws shall have a minimum 5 micron zinc coating in accordance with ASTM F1941. Screws, bolts, and anchors shall be hot-dipped galvanized in accordance with ASTM A123/A123M or ASTM A153/A153M as appropriate. Screws bolts, and anchors shall be hot dipped galvanized in accordance with ASTM A123/A123M or ASTM A153/A153M as appropriate.

PART 3 EXECUTION

3.1 FASTENING

Fasten framing members together by welding or by using self-drilling or self-tapping screws. Electrodes and screw connections shall be as required and indicated in the design calculations.

3.1.1 Welds

All welding shall be performed in accordance with AWS D1.3/D1.3M, as modified by AISI SG02-KIT. All welders, welding operations, and welding procedures shall be qualified according to AWS D1.3/D1.3M. All welds shall be cleaned and coated with rust inhibitive galvanizing paint. Do not field weld materials lighter than 18 gage.

3.1.2 Screws

Screws shall be self-drilling self-tapping type, size, and location shown on the drawings. Screw penetration through joined materials shall not be less than three exposed threads. Minimum spacings and edge distances for screws shall be as specified in AISI SG02-KIT.

3.2 INSTALLATION

Install cold-formed framing in accordance with ASTM C1007 and AISI S200.

Install cold-formed steel framing according to AISI S202 and to manufacturer's written instructions unless more stringent requirements are indicated.

3.2.1 Joists

Locate each joist or truss directly above a stud. Joist shall be reinforced over bearings where required to prevent web crippling. Joist shall not be spliced. Provide manufacturer's standard bridging which shall not be less than the following:

| CLEAR SPAN | BRIDGING |
|---|---|
| Up to 14 feet | One row near center |

-- End of Section 05 40 00 --

SECTION 05 50 13
MISCELLANEOUS METAL FABRICATIONS

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

| | |
|---|---|
| AISC 303 | (2010) Code of Standard Practice for Steel Buildings and Bridges |

AMERICAN WELDING SOCIETY (AWS)

| | |
|---|---|
| AWS D1.1/D1.1M | (2010; Errata 2011) Structural Welding Code - Steel |

ASME INTERNATIONAL (ASME)

| | |
|---|---|
| ASME B18.2.1 | (2012; Errata 2013) Square and Hex Bolts and Screws (Inch Series) |
| ASME B18.2.2 | (2010) Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series) |
| ASME B18.21.1 | (2009) Washers: Helical Spring-Lock, Tooth Lock, and Plain Washers (Inch Series) |
| ASME B18.6.2 | (1998; R 2010) Slotted Head Cap Screws, Square Head Set Screws, and Slotted Headless Set Screws: Inch Series |
| ASME B18.6.3 | (2013) Machine Screws, Tapping Screws, and Machine Drive Screws (Inch Series) |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A123/A123M | (2013) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products |
| ASTM A153/A153M | (2009) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware |

| | |
|---|---|
| ASTM A307 | (2012) Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength |
| ASTM A36/A36M | (2012) Standard Specification for Carbon Structural Steel |
| ASTM A47/A47M | (1999; R 2014) Standard Specification for Ferritic Malleable Iron Castings |
| ASTM A48/A48M | (2003; R 2012) Standard Specification for Gray Iron Castings |
| ASTM A500/A500M | (2013) Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes |
| ASTM A53/A53M | (2012) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless |
| ASTM A653/A653M | (2013) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process |
| ASTM A780/A780M | (2009) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings |
| ASTM A924/A924M | (2013) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process |
| ASTM B209 | (2010) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate |
| ASTM C1513 | (2013) Standard Specification for Steel Tapping Screws for Cold-Formed Steel Framing Connections |
| ASTM D1187/D1187M | (1997; E 2011; R 2011) Asphalt-Base Emulsions for Use as Protective Coatings for Metal |
| ASTM E488/E488M | (2010) Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements |

MASTER PAINTERS INSTITUTE (MPI)

| | |
|---|---|
| MPI 79 | (Oct 2009) Alkyd Anti-Corrosive Metal Primer |

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

NAAMM MBG 531 (2009) Metal Bar Grating Manual

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 3 (1982; E 2004) Power Tool Cleaning

SSPC SP 6/NACE No.3 (2007) Commercial Blast Cleaning

## 1.2 SUBMITTALS

Contracting Officer's written approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Submit fabrication drawings showing layout(s), connections to structural system, and anchoring details as specified in AISC 303. Submit templates, erection and installation drawings indicating thickness, type, grade, class of metal, and dimensions. Show construction details, reinforcement, anchorage, and installation with relation to the building construction.

Gratings and walkways, installation drawings

SD-03 Product Data

Gratings and walkways

## 1.3 QUALIFICATION OF WELDERS

The contractor shall obtain the services of qualified welders in accordance with AWS D1.1/D1.1M. Use procedures, materials, and equipment of the type required for the work.

## 1.4 DELIVERY, STORAGE, AND PROTECTION

Protect from corrosion, deformation, and other types of damage. Store items in an enclosed area free from contact with soil and weather. Remove and replace damaged items with new items.

# PART 2 PRODUCTS

## 2.1 MATERIALS

### 2.1.1 Structural Carbon Steel

ASTM A36/A36M.

2.1.2 Structural Tubing

ASTM A500/A500M.

2.1.3 Steel Pipe

ASTM A53/A53M, Type E or S, Grade B.

2.1.4 Fittings for Steel Pipe

Standard malleable iron fittings ASTM A47/A47M.

2.1.5 Gratings

a. Gray cast iron ASTM A48/A48M, Class 40.

b. Metal plank grating, non-slip requirement, aluminum ASTM B209, 6061-T6; steel ASTM A653/A653M, G90.

c. Metal bar type grating NAAMM MBG 531.

2.1.6 Anchor Bolts

ASTM A307. Where exposed, shall be of the same material, color, and finish as the metal to which applied.

2.1.6.1 Expansion Anchors and Adhesive Anchors

Provide expansion anchors or adhesive anchors. Minimum concrete embedment shall be 3-1/2 in. Design values listed shall be as tested according to ASTM E488/E488M.

a. Minimum allowable pullout value shall be 3,200 lbs.

b. Minimum allowable shear value shall be 2,000 lbs.

2.1.6.2 Lag Screws and Bolts

ASME B18.2.1, type and grade best suited for the purpose.

2.1.6.3 Bolts, Nuts, Studs and Rivets

ASME B18.2.2 or ASTM A307.

2.1.6.4 Screws

ASME B18.2.1, ASME B18.6.2, ASME B18.6.3 and ASTM C1513.

2.1.6.5 Washers

Provide plain washers to conform to ASME B18.21.1. Provide beveled washers for American Standard beams and channels, square or rectangular, tapered in thickness, and smooth. Provide lock washers to conform to ASME B18.21.1.

2.2 FABRICATION FINISHES

2.2.1 Galvanizing

Hot-dip galvanize items specified to be zinc-coated, after fabrication where practicable. Galvanizing: ASTM A123/A123M, ASTM A153/A153M, ASTM A653/A653M or ASTM A924/A924M, G90, as applicable.

2.2.2 Galvanize

Anchor bolts, grating fasteners, washers, and parts or devices necessary for proper installation, unless indicated otherwise.

2.2.3 Repair of Zinc-Coated Surfaces

Repair damaged surfaces with galvanizing repair method and paint conforming to ASTM A780/A780M or by application of stick or thick paste material specifically designed for repair of galvanizing, as approved by Contracting Officer. Clean areas to be repaired and remove slag from welds. Heat surfaces to which stick or paste material is applied, with a torch to a temperature sufficient to melt the metallics in stick or paste; spread molten material uniformly over surfaces to be coated and wipe off excess material.

2.2.4 Shop Cleaning and Painting

2.2.4.1 Surface Preparation

Blast clean surfaces in accordance with SSPC SP 6/NACE No.3. Surfaces that will be exposed in spaces above ceiling or in attic spaces, crawl spaces, furred spaces, and chases may be cleaned in accordance with SSPC SP 3 in lieu of being blast cleaned. Wash cleaned surfaces which become contaminated with rust, dirt, oil, grease, or other contaminants with solvents until thoroughly clean. Steel to be embedded in concrete shall be free of dirt and grease. Do not paint or galvanize bearing surfaces, including contact surfaces within slip critical joints, but coat with rust preventative applied in the shop.

2.2.4.2 Pretreatment, Priming and Painting

Apply pretreatment, primer, and paint in accordance with manufacturer's printed instructions. On surfaces concealed in the finished construction or not accessible for finish painting, apply an

additional prime coat to a minimum dry film thickness of 1.0 mil. Tint additional prime coat with a small amount of tinting pigment.

2.2.5 Nonferrous Metal Surfaces

Protect by plating, anodic, or organic coatings.

2.3 GRATINGS AND WALKWAYS

Design aluminum grating in accordance with MBG 532 for bar type grating or manufacturer's charts for plank grating. Galvanize steel floor gratings.

a. Design floor gratings to support a live load of 60 pounds per square foot for the spans indicated, with maximum deflection of L/240.

--or--

b. Attach gratings to structural members with welded-on anchors or bolts, expansion shields and bolts.

c. Slip resistance requirements must exceed both wet and dry a static coefficient of friction of 0.5.

2.4 GUARD POSTS (BOLLARDS/PIPE GUARDS)

Provide galvanized and prime coated standard weight steel pipe as specified in ASTM A53/A53M. Anchor posts in concrete as indicated and fill solidly with concrete with minimum compressive strength of 2500 psi.

PART 3 EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

Install items at locations indicated, according to manufacturer's instructions. Verify all measurements and take all field measurements necessary before fabrication. Exposed fastenings shall be compatible materials, shall generally match in color and finish, and harmonize with the material to which fastenings are applied. Include materials and parts necessary to complete each item, even though such work is not definitely shown or specified. Poor matching of holes for fasteners shall be cause for rejection. Conceal fastenings where practicable. Thickness of metal and details of assembly and supports shall provide strength and stiffness. Form joints exposed to the weather shall be formed to exclude water. Items listed below require additional procedures.

3.2 WORKMANSHIP

Provide miscellaneous metalwork that is well formed to shape and size, with sharp lines and angles and true curves. Drilling and punching shall produce clean true lines and surfaces.

Provide continuous welding along the entire area of contact except where tack welding is permitted. Do not tack weld exposed connections of work in place and ground smooth. Provide a smooth finish on exposed surfaces of work in place and unless otherwise approved, flush exposed riveting. Mill joints where tight fits are required. Corner joints shall be coped or mitered, well formed, and in true alignment. Accurately set work to established lines and elevations and securely fastened in place. Install in accordance with manufacturer's installation instructions and approved fabrication drawings, cuts, and details.

## 3.3 ANCHORAGE, FASTENINGS, AND CONNECTIONS

Provide anchorage where necessary for fastening miscellaneous metal items securely in place. Include for anchorage not otherwise specified or indicated slotted inserts, expansion shields, and powder-driven fasteners, when approved for concrete; toggle bolts and through bolts for masonry; machine and carriage bolts for steel; through bolts, lag bolts, and screws for wood. Do not use wood plugs in any material. Provide non-ferrous attachments for non-ferrous metal. Make exposed fastenings of compatible materials, generally matching in color and finish, to which fastenings are applied. Conceal fastenings where practicable.

## 3.4 BUILT-IN WORK

Form for anchorage metal work built-in with concrete or masonry, or provide with suitable anchoring devices as indicated or as required. Furnish metal work in ample time for securing in place as the work progresses.

## 3.5 WELDING

Perform welding, welding inspection, and corrective welding, in accordance with AWS D1.1/D1.1M. Use continuous welds on all exposed connections. Grind visible welds smooth in the finished installation.

## 3.6 FINISHES

### 3.6.1 Dissimilar Materials

Where dissimilar metals are in contact, protect surfaces with a coat conforming to MPI 79 to prevent galvanic or corrosive action. Where aluminum is in contact with concrete, plaster, mortar, masonry, wood, or absorptive materials subject to wetting, protect with ASTM D1187/D1187M, asphalt-base emulsion.

### 3.6.2 Field Preparation

Remove rust preventive coating just prior to field erection, using a remover approved by the rust preventive manufacturer. Surfaces, when assembled, shall be free of rust, grease, dirt and other foreign matter.

### 3.6.3 Environmental Conditions

Do not clean or paint surface when damp or exposed to foggy or rainy weather, when metallic surface temperature is less than 5 degrees F above the dew point of the surrounding air, or when surface temperature is below 45 degrees F or over 95 degrees F, unless approved by the Contracting Officer.

## 3.7 INSTALLATION OF GUARD POSTS (BOLLARDS/PIPE GUARDS)

Set pipe guards vertically in concrete piers. Construct piers of, and the hollow cores of the pipe filled with, concrete having a compressive strength of 3000 psi.

-- End of Section 05 50 13 --

SECTION 05 51 33
ALTERNATING TREAD METAL LADDERS

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN WELDING SOCIETY (AWS)

| | |
|---|---|
| AWS D1.1/D1.1M | (2010; Errata 2011) Structural Welding Code - Steel |

AMERICAN IRON AND STEEL INSTITUTE (AISI)

| | |
|---|---|
| AISI 1010/15 | (2015) Carbon Steel |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A123/A123M | (2013) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products |
| ASTM A153/A153M | (2009) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware |
| ASTM A36/A36M | (2012) Standard Specification for Carbon Structural Steel |
| ASTM A47/A47M | (1999; R 2014) Standard Specification for Ferritic Malleable Iron Castings |
| ASTM A500/A500M | (2013) Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes |
| ASTM A513/A513M | (2012) Standard Specification for Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing |
| ASTM A53/A53M | (2012) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless |
| ASTM A569/A1011 | Standard Specification for Steel Carbon |
| ASTM A653/A653M | (2013) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process |

| | |
|---|---|
| ASTM A780/A780M | (2009) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings |
| ASTM A924/A924M | (2013) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process |
| ASTM D1187/D1187M | (1997; E 2011; R 2011) Asphalt-Base Emulsions for Use as Protective Coatings for Metal |

MASTER PAINTERS INSTITUTE (MPI)

| | |
|---|---|
| MPI 79 | (Oct 2009) Alkyd Anti-Corrosive Metal Primer |

## 1.2 SUBMITTALS

Contracting Officer's written approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Alternating Tread Ladders, installation drawings

SD-03 Product Data

Alternating Tread Ladders

## 1.3 QUALIFICATION OF WELDERS

Qualify welders in accordance with AWS D1.1/D1.1M. Use procedures, materials, and equipment of the type required for the work.

## 1.4 DELIVERY, STORAGE, AND PROTECTION

Protect from corrosion, deformation, and other types of damage. Store items in an enclosed area free from contact with soil and weather. Remove and replace damaged items with new items.

# PART 2 PRODUCTS

## 2.1 MATERIALS

### 2.1.1 Structural Carbon Steel

ASTM A36/A36M.

2.1.2 Structural Tubing

ASTM A500/A500M.

2.1.3 Steel Pipe

ASTM A53/A53M, Type E or S, Grade B.

2.1.4 Fittings for Steel Pipe

Standard malleable iron fittings ASTM A47/A47M.

2.2 FABRICATION FINISHES

2.2.1 Galvanizing

Hot-dip galvanize items after fabrication where practicable. Galvanizing: ASTM A123/A123M, ASTM A153/A153M, ASTM A653/A653M or ASTM A924/A924M, G90, as applicable.

2.2.2 Galvanize

Ladder components, anchor bolts, washers, and parts or devices necessary for proper installation, unless indicated otherwise.

2.2.3 Repair of Zinc-Coated Surfaces

Repair damaged surfaces with galvanizing repair method and paint conforming to ASTM A780/A780M or by application of stick or thick paste material specifically designed for repair of galvanizing, as approved by Contracting Officer's Representative. Clean areas to be repaired and remove slag from welds. Heat surfaces to which stick or paste material is applied, with a torch to a temperature sufficient to melt the metallics in stick or paste; spread molten material uniformly over surfaces to be coated and wipe off excess material.

2.3 ALTERNATING TREAD LADDERS

Fabricate stringers and framing of steel plate or shapes. Bolt, rivet or weld connections and anchor to supporting construction. Provide treads with non-slip surface as specified for safety treads. Design assembly, including tread connections and methods of attachment, to support a live load of 300 pounds per tread. Provide railings as specified for metal handrails. Angle of ladder shall be 68 degrees from horizontal.

2.3.1 Components

2.3.1.1 Treads

13 gauge AISI 1010/15 Hot Rolled Pickled and Oiled per ASTM A569/A1011 grade 36 (or higher).

2.3.1.2 Landing and Foot Stampings

11 gauge AISI 1010/15 per ASTM A569/A1011 grade 36 (or higher).

2.3.1.3 Top Landing Support Clips

L2 x 2 x 1/4" x 4" long with 5/8" diameter round holes and 5/8" x 1" slot holes, ASTM A569/A1011 grade 36 (or higher).

2.3.1.4 Stringers

a. 2" x 1-3/4" x 11 gauge U section; AISI 1010/15 per ASTM A569/A1011 grade 36 (or higher) for 56 degree stairs under 10 vertical feet and for 68 degree stairs under 12 vertical feet.

b. 3" x 1-3/4 x 11 gauge U section; AISI 1010/15 per ASTM A569/A1011 grade 36 (or higher) for 56 degree stairs over 10 vertical feet and for 68 degree stairs over 12 vertical feet.

2.3.1.5 Handrails

1-1/2" OD x 0.083" AISI 1010/15 CS per ASTM A569/A1011 cold drawn, fully annealed tube per ASTM A513/A513M, Grade 1008 or higher As-welded tubing or ASTM A500/A500M, Grade B.

PART 3 EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

Install items at locations indicated, according to manufacturer's instructions. Verify all measurements and take all field measurements necessary before fabrication. Provide Exposed fastenings of compatible materials, generally matching in color and finish, and harmonize with the material to which fastenings are applied. Include materials and parts necessary to complete each item, even though such work is not definitely shown or specified. Poor matching of holes for fasteners will be cause for rejection. Conceal fastenings where practicable. Thickness of metal and details of assembly and supports must provide strength and stiffness. Formed joints exposed to the weather to exclude water. Items listed below require additional procedures.

3.2 WORKMANSHIP

Metalwork must be well formed to shape and size, with sharp lines and angles and true curves. Drilling and punching must produce clean true lines and surfaces. Continuously weld along the entire area of contact. Do not tack weld exposed connections of work in place. Grid smooth

exposed welds. Provide smooth finish on exposed surfaces of work in place, unless otherwise approved. Where tight fits are required, mill joints. Cope or miter corner joints, well formed, and in true alignment. Install in accordance with manufacturer's installation instructions and approved drawings, cuts, and details.

## 3.3 ANCHORAGE, FASTENINGS, AND CONNECTIONS

Provide anchorage where necessary for fastening metal items securely in place. Include for anchorage not otherwise specified or indicated slotted inserts, expansion anchors,and powder-actuated fasteners, when approved for concrete; toggle bolts and through bolts for masonry; machine bolts, carriage bolts and powder-actuated threaded studs for steel; through bolts, lag bolts, and screws for wood. Do not use wood plugs in any material. Provide non-ferrous attachments for non-ferrous metal. Make exposed fastenings of compatible materials, generally matching in color and finish, to which fastenings are applied. Conceal fastenings where practicable.

## 3.4 WELDING

Perform welding, welding inspection, and corrective welding, in accordance with AWS D1.1/D1.1M. Use continuous welds on all exposed connections. Grind visible welds smooth in the finished installation.

## 3.5 FINISHES

### 3.5.1 Dissimilar Materials

Where dissimilar metals are in contact, protect surfaces with a coat conforming to MPI 79 to prevent galvanic or corrosive action. Where aluminum is in contact with concrete, plaster, mortar, masonry, wood, or absorptive materials subject to wetting, protect with ASTM D1187/D1187M, asphalt-base emulsion.

### 3.5.2 Field Preparation

Remove rust preventive coating just prior to field erection, using a remover approved by the rust preventive manufacturer. Surfaces, when assembled, must be free of rust, grease, dirt and other foreign matter.

### 3.5.3 Environmental Conditions

Do not clean or paint surface when damp or exposed to foggy or rainy weather, when metallic surface temperature is less than 5 degrees F above the dew point of the surrounding air, or when surface temperature is below 45 degrees F or over 95 degrees F, unless approved by the Contracting Officer.

## 3.6 ALTERNATING TREAD LADDERS

Secure to the adjacent construction with the clip angles attached to the stringer. Install intermediate clip angles not over 48 inches on center. Install brackets as required for securing of ladders welded or bolted to structural steel.

-- End of Section 05 51 33 --

SECTION 05 52 00
METAL RAILINGS

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN WELDING SOCIETY (AWS)

| | |
|---|---|
| AWS D1.1/D1.1M | (2010; Errata 2011) Structural Welding Code - Steel |

ASME INTERNATIONAL (ASME)

| | |
|---|---|
| ASME B18.21.1 | (2009) Washers: Helical Spring-Lock, Tooth Lock, and Plain Washers (Inch Series) |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A123/A123M | (2013) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products |
| ASTM A153/A153M | (2009) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware |
| ASTM A307 | (2012) Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength |
| ASTM A53/A53M | (2012) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless |

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

| | |
|---|---|
| NAAMM AMP 521 | (2001) Pipe Railing Manual |

1.2 SUBMITTALS

Contracting Officer's written approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fabrication Drawings

Iron and Steel Hardware

Steel Shapes, Plates, Bars and Strips

SD-03 Product Data

Protective Coating

Steel Railings and Handrails

SD-07 Certificates

Welding Procedures

Welder Qualification

SD-08 Manufacturer's Instructions

Installation Instructions

## 1.3 QUALITY ASSURANCE

### 1.3.1 Welding Procedures

Submit welding procedures testing in accordance with AWS D1.1/D1.1M made in the presence of the Contracting Officer's Representative and by an approved testing laboratory at the Contractor's expense.

### 1.3.2 Welder Qualification

Submit certified welder qualification by tests in accordance with AWS D1.1/D1.1M, or under an equivalent approved qualification test. Perform on test pieces in positions and with clearances equivalent to those actually encountered. If a test weld fails to meet requirements, make an immediate retest of two test welds and ensure each test weld passes. Failure in the immediate retest will require that the welder be retested after further practice or training and make a complete set of test welds.

# PART 2 PRODUCTS

## 2.1 SYSTEM DESCRIPTION

Provide complete, detailed fabrication and installation drawings for all iron and steel hardware, and for all steel shapes, plates, bars and strips used in accordance with the design specifications referenced in this section.

Pre-assemble items in the shop to the greatest extent possible. Disassemble units only to the extent necessary for shipping and handling. Clearly mark units for reassembly and coordinated installation.

For the fabrication of work exposed to view, use only materials that are smooth and free of surface blemishes, including pitting, seam marks, roller marks, rolled trade names, and roughness. Remove blemishes by grinding, or by welding and grinding, prior to cleaning, treating, and application of surface finishes, including zinc coatings.

## 2.2 GENERAL FABRICATION

Provide railings and handrails detail plans and elevations at not less than 1 inch to 1 foot. Provide details of sections and connections at not less than 3 inches to 1 foot. Also detail setting drawings, diagrams, templates for installation of anchorages, including concrete inserts, anchor bolts, and miscellaneous metal items having integral anchors.

Use materials of size and thicknesses indicated or, if not indicated, of required size and thickness to produce adequate strength and durability in finished product for intended use. Work materials to dimensions indicated on approved detail drawings, using proven details of fabrication and support. Use type of materials indicated or specified for the various components of work.

Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges. Ensure all exposed edges are eased to a radius of approximately 1/32 inch. Bend metal corners to the smallest radius possible without causing grain separation or otherwise impairing the work.

Weld corners and seams continuously and in accordance with the recommendations of AWS D1.1/D1.1M. Grind exposed welds smooth and flush to match and blend with adjoining surfaces.

Form exposed connections with hairline joints that are flush and smooth, using concealed fasteners wherever possible. Use exposed fasteners of the type indicated or, if not indicated, use Phillips flathead (countersunk) screws or bolts.

Provide anchorage of the type indicated and coordinated with the supporting structure. Fabricate anchoring devices and space as indicated and as required to provide adequate support for the intended use of the work.

Use hot-rolled steel bars for work fabricated from bar stock unless work is indicated or specified to be fabricated from cold-finished or cold-rolled stock.

## 2.3 STEEL PIPE

Provide pipe conforming to ASTM A53/A53M, type as selected, Grade B; primed finish, unless galvanizing is required; standard weight (Schedule 40).

## 2.4 FASTENERS

Provide galvanized zinc-coated fasteners in accordance with ASTM A153/A153M used for exterior applications or where built into exterior walls or floor systems. Select fasteners for the type, grade, and class required for the installation of steel stair items.

Provide standard hexagon-head bolts, conforming to ASTM A307, Grade A.

Provide plain round, general-assembly-grade, carbon steel washers conforming to ASME B18.21.1.

## 2.5 PROTECTIVE COATING

Provide hot dipped galvanized steelwork as indicated in accordance with ASTM A123/A123M. Touch up abraded surfaces and cut ends of galvanized members with zinc-dust, zinc-oxide primer, or an approved galvanizing repair compound.

## 2.6 STEEL RAILINGS AND HANDRAILS

Design handrails to resist a concentrated load of 250 lbs in any direction at any point of the top of the rail or 20 lbs per foot applied horizontally to top of the rail, whichever is more severe. Provide pipe collars of the same material and finish as the handrail and posts.

### 2.6.1 Steel Handrails

Provide steel handrails, including inserts in concrete, and steel pipe conforming to ASTM A53/A53M. Provide steel railings of 1 1/2 inches nominal size, hot-dip galvanized.

a. Fabrication: Joint posts, rail, and corners by one of the following methods:

(1) Flush-type rail fittings of commercial standard, welded and ground smooth with railing splice locks secured with 3/8 inchhexagonal-recessed-head setscrews.

(2) Mitered and welded joints made by fitting post to top rail and intermediate rail to post, mitering corners, groove welding joints, and grinding smooth. Butt railing splices and reinforce them by a tight fitting interior sleeve not less than 6 inches long.

(3) Railings may be bent at corners in lieu of jointing, provided bends are made in suitable jigs and the pipe is not crushed.

b. Provide removable sections as indicated.

Provide kickplates between railing posts where indicated, and consist of 1/8-inch steel flat bars not less than 6 inches high. Secure kickplates as indicated.

Provide galvanized railings, including pipe, fittings, brackets, fasteners, and other ferrous metal components.

2.6.2 Woven Wire Mesh Panels

Provide woven wire mesh panels within steel channel framing welded to steel handrails as indicated on the drawings.

a. Fabrication:

1. Panel frames shall be 1" x 1/2" steel channels fully welded to handrails, all joints mitered, welded and ground smooth.

2. Woven wire mesh shall be #10 gauge steel wire woven into 1-1/2" diamond mesh pattern, securely clinched to frame and welded.

3. Finish entire fabrication along with handrails with machinery gray enamel.

PART 3 EXECUTION

3.1 INSTALLATION INSTRUCTIONS

Submit manufacturer's installation instructions for the following products to be used in the fabrication of steel stair railing and hand rail work:

a. Protective coating

b. Steel railings and handrails

c. Anchorage and fastening systems

Provide complete, detailed fabrication and installation drawings for all iron and steel hardware, and for all steel shapes, plates, bars and strips used in accordance with the design specifications referenced in this section.

3.2 PREPARATION

Adjust stair railings and handrails prior to securing in place to ensure proper matching at butting joints and correct alignment throughout their length. Space posts not more than 5 feet on center. Plumb posts in each direction. Secure posts and rail ends to building construction as follows:

Anchor posts in concrete by means of pipe sleeves set and anchored into concrete. Provide sleeves of galvanized, standard weight, steel pipe, not less than 6 inches long, and having an inside diameter not less than 1/2-inch greater than the outside diameter of the inserted pipe post. Provide steel plate closure secured to the bottom of the sleeve, with closure width and length not less than 1-inch greater than the outside diameter of the sleeve. After posts have

been inserted into sleeves, fill the annular space between post and sleeve with molten lead, sulfur, or a quick-setting hydraulic cement. Cover anchorage joint with a round steel flange welded to the post.

Anchor posts to steel with steel oval flanges, angle type or floor type as required by conditions, welded to posts and bolted to the steel supporting members.

Anchor rail ends into concrete and masonry with steel round flanges welded to rail ends and anchored into the wall construction with lead expansion shields and bolts.

Anchor rail ends to steel with steel oval or round flanges welded to tail ends and bolted to the structural steel members.

Secure handrails to walls by means of wall brackets and wall return fitting at handrail ends. Provide brackets of malleable iron castings, with not less than 3-inch projection from the finish wall surface to the center of the pipe drilled to receive one 3/8-inch bolt. Locate brackets not more than 60 inches on center. Provide wall return fittings of cast iron castings, flush-type, with the same projection as that specified for wall brackets. Secure wall brackets and wall return fittings to building construction as follows:

For concrete and solid masonry anchorage, use bolt anchor expansion shields and lag bolts.

For hollow masonry and stud partition anchorage, use toggle bolts having square heads.

Install toe boards and brackets where indicated. Make splices, where required, at expansion joints. Install removable sections as indicated.

## 3.3 STEEL HANDRAIL

Install in pipe sleeves embedded in concrete and filled with non-shrink grout or quick setting anchoring cement with anchorage covered with standard pipe collar pinned to post or by means of base plates bolted to stringers or structural steel frame work. Secure rail ends by steel pipe flanges anchored by expansion shields and bolts or through-bolted to a back plate or by 1/4 inch lag bolts to studs or solid backing.

## 3.4 FIELD WELDING

Ensure procedures of manual shielded metal arc welding, appearance and quality of welds made, and methods used in correcting welding work comply with AWS D1.1/D1.1M.

-- End of Section 05 52 00 --

SECTION 07 21 16
MINERAL FIBER BLANKET INSULATION

PART 1 GENERAL

1.1 REFERENCES

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

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM C665 | (2012) Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing |
| ASTM C930 | (2012) Potential Health and Safety Concerns Associated with Thermal Insulation Materials and Accessories |
| ASTM E84 | (2014) Standard Test Method for Surface Burning Characteristics of Building Materials |

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

| | |
|---|---|
| 29 CFR 1910.134 | Respiratory Protection |

1.2 SUBMITTALS

Contracting Officer's written approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Blanket insulation

Accessories

SD-08 Manufacturer's Instructions

Insulation

1.3 DELIVERY, STORAGE, AND HANDLING

1.3.1 Delivery

Deliver materials to site in original sealed wrapping bearing manufacturer's name and brand designation, specification number, type, grade, R-value, and class. Store and handle to protect

from damage. Do not allow insulation materials to become wet, soiled, crushed, or covered with ice or snow. Comply with manufacturer's recommendations for handling, storing, and protecting of materials before and during installation.

1.3.2 Storage

Inspect materials delivered to the site for damage; unload and store out of weather in manufacturer's original packaging. Store only in dry locations, not subject to open flames or sparks, and easily accessible for inspection and handling.

1.4 SAFETY PRECAUTIONS

1.4.1 Respirators

Provide installers with dust/mist respirators, training in their use, and protective clothing, all approved by National Institute for Occupational Safety and Health (NIOSH)/Mine Safety and Health Administration (MSHA) in accordance with 29 CFR 1910.134.

1.4.2 Smoking

Do not smoke during installation of blanket thermal insulation.

1.4.3 Other Safety Concerns

Consider other safety concerns and measures as outlined in ASTM C930.

PART 2 PRODUCTS

2.1 BLANKET INSULATION

ASTM C665, Type II, blankets with non-reflecting coverings; Class A, vinyl-faced surface with a flame spread of 25 or less when tested in accordance with ASTM E84.

2.1.1 Thermal Resistance Value (R-VALUE)

R-11 for fiberglass insulation at walls and ceilings.

2.1.2 Recycled Materials

Provide Thermal Insulation containing recycled materials to the extent practicable, provided the material meets all other requirements of this section. The minimum required recycled materials content by weight are:

Rock Wool: 75 percent slag
Fiberglass: 20 to 25 percent glass cullet

2.1.3 Prohibited Materials

Do not provide asbestos-containing materials.

2.2 ACCESSORIES

2.2.1 Mechanical Fasteners

Corrosion resistant fasteners as recommended by the insulation manufacturer.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Insulation

Install and handle insulation in accordance with manufacturer's instructions. Keep material dry and free of extraneous materials. Ensure personal protective clothing and respiratory equipment is used as required. Observe safe work practices.

3.1.1.1 Electrical wiring

Do not install insulation in a manner that would sandwich electrical wiring between two layers of insulation.

3.1.1.2 Continuity of Insulation

Install blanket insulation to butt tightly against adjoining blankets and to studs, rafters, joists, sill plates, headers and any obstructions. Provide continuity and integrity of insulation at corners, wall to ceiling joints, roof, and floor. Avoid creating thermal bridges.

3.1.1.3 Sizing of Blankets

Provide only full width blankets when insulating between trusses, joists, or studs. Size width of blankets for a snug fit where trusses, joists or studs are irregularly spaced.

-- End of Section 07 21 16 --

SECTION 07 60 00
FLASHING AND SHEET METAL

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN WELDING SOCIETY (AWS)

| | |
|---|---|
| AWS D1.2/D1.2M | (2014) Structural Welding Code - Aluminum |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM B209 | (2010) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate |

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

| | |
|---|---|
| SMACNA 1793 | (2012) Architectural Sheet Metal Manual, 7th Edition |

1.2 GENERAL REQUIREMENTS

Finished sheet metalwork will form a weathertight construction without waves, warps, buckles, fastening stresses or distortion, which allows for expansion and contraction. Sheet metal mechanic is responsible for cutting, fitting, drilling, and other operations in connection with sheet metal required to accommodate the work of other trades. Coordinate installation of sheet metal items used in conjunction with roofing with roofing work to permit continuous roofing operations.

1.3 SUBMITTALS

Contracting Officer's written approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Covering on flat, sloped, or curved surfaces

Sill flashing

Indicate thicknesses, dimensions, fastenings and anchoring methods, expansion joints, and other provisions necessary for thermal expansion and contraction. Scaled manufacturer's catalog data may be submitted for factory fabricated items.

## 1.4 DELIVERY, HANDLING, AND STORAGE

Package and protect materials during shipment. Uncrate and inspect materials for damage, dampness, and wet-storage stains upon delivery to the job site. Remove from the site and replace damaged materials that cannot be restored to like-new condition. Handle sheet metal items to avoid damage to surfaces, edges, and ends. Store materials in dry, weather-tight, ventilated areas until immediately before installation.

# PART 2 PRODUCTS

## 2.1 MATERIALS

Do not use lead, lead-coated metal, or galvanized steel. Use any metal listed by SMACNA Arch. Manual for a particular item, unless otherwise specified or indicated. Conform to the requirements specified and to the thicknesses and configurations established in SMACNA Arch. Manual for the materials. Different items need not be of the same metal, except that if copper is selected for any exposed item, all exposed items must be copper.

Furnish sheet metal items in 8 to 10 foot lengths. Single pieces less than 8 feet long may be used to connect to factory-fabricated inside and outside corners, and at ends of runs. Factory fabricate corner pieces with minimum 12 inch legs. Provide accessories and other items essential to complete the sheet metal installation. Provide accessories made of the same or compatible materials as the items to which they are applied. Fabricate sheet metal items of the materials specified below and to the gage, thickness, or weight shown in Table I at the end of this section. Provide sheet metal items with mill finish unless specified otherwise. Where more than one material is listed for a particular item in Table I, each is acceptable and may be used except as follows:

### 2.1.1 Exposed Sheet Metal Items

Must be of the same material. Consider the following as exposed sheet metal: gutters, including hangers; downspouts; gravel stops and fascias; cap, valley, steeped, base, and eave flashings and related accessories.

### 2.1.2 Drainage

Do not use copper for an exposed item if drainage from that item will pass over exposed masonry, stonework or other metal surfaces. In addition to the metals listed in Table I, lead-coated copper may be used for such items.

### 2.1.3 Aluminum Alloy Sheet and Plate

ASTM B209 anodized clear form alloy, and temper appropriate for use.

2.1.3.1 Alclad

When fabricated of aluminum, fabricate the items Alclad 3003, Alclad 3004, Alclad 3005, clad on both sides unless otherwise indicated.

a. Flashing

2.1.3.2 Finish

Exposed exterior sheet metal items of aluminum must have a baked-on, factory-applied color coating of polyvinylidene fluoride (PVF2) or other equivalent fluorocarbon coating applied after metal substrates have been cleaned and pretreated. Provide finish coating dry-film thickness of 0.8 to 1.3 mils and color as indicated.

2.1.4 Fasteners

Use the same metal or a metal compatible with the item fastened. Use stainless steel fasteners to fasten dissimilar materials.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Workmanship

Make lines and angles sharp and true. Free exposed surfaces from visible wave, warp, buckle, and tool marks. Fold back exposed edges neatly to form a 1/2 inch hem on the concealed side. Make sheet metal exposed to the weather watertight with provisions for expansion and contraction.

Make surfaces to receive sheet metal plumb and true, clean, even, smooth, dry, and free of defects and projections. For installation of items not shown in detail or not covered by specifications conform to the applicable requirements of SMACNA 1793, Architectural Sheet Metal Manual. Provide sheet metal flashing in the angles formed where roof decks abut walls, curbs, ventilators, pipes, or other vertical surfaces and wherever indicated and necessary to make the work watertight. Join sheet metal items together as shown in Table II.

3.1.2 Nailing

Confine nailing of sheet metal generally to sheet metal having a maximum width of 18 inch. Confine nailing of flashing to one edge only. Space nails evenly not over 3 inch on center and approximately 1/2 inch from edge unless otherwise specified or indicated. Face nailing will not be permitted. Where sheet metal is applied to other than wood surfaces, include in shop drawings, the locations for sleepers and nailing strips required to secure the work.

### 3.1.3 Cleats

Provide cleats for sheet metal 18 inch and over in width. Space cleats evenly not over 12 inch on center unless otherwise specified or indicated. Unless otherwise specified, provide cleats of 2 inch wide by 3 inch long and of the same material and thickness as the sheet metal being installed. Secure one end of the cleat with two nails and the cleat folded back over the nailheads. Lock the other end into the seam. Where the fastening is to be made to concrete or masonry, use screws and drive in expansion shields set in concrete or masonry. Pretin cleats for soldered seams.

### 3.1.4 Bolts, Rivets, and Screws

Install bolts, rivets, and screws where indicated or required. Provide compatible washers where required to protect surface of sheet metal and to provide a watertight connection. Provide mechanically formed joints in aluminum sheets 0.040 inch or less in thickness.

### 3.1.5 Seams

Straight and uniform in width and height with no solder showing on the face.

#### 3.1.5.1 Flat-lock Seams

Finish not less than 3/4 inch wide.

#### 3.1.5.2 Flat Seams

Make seams in the direction of the flow.

### 3.1.6 Soldering

Seal the joints in aluminum sheets of 0.040 inch or less in thickness with specified sealants. Do not solder aluminum.

#### 3.1.6.1 Edges

Seal the joints in aluminum sheets of 0.040 inch or less in thickness with specified sealants. Do not solder aluminum.

### 3.1.7 Welding and Mechanical Fastening

Use welding for aluminum of thickness greater than 0.040 inch. Aluminum 0.040 inch or less in thickness must be butted and the space backed with formed flashing plate; or lock joined, mechanically fastened, and filled with sealant as recommended by the aluminum manufacturer.

3.1.7.1 Welding of Aluminum

Use welding of the inert gas, shield-arc type. For procedures, appearance and quality of welds, and the methods used in correcting welding work, conform to AWS D1.2/D1.2M.

3.1.7.2 Mechanical Fastening of Aluminum

Use No. 12, aluminum alloy, sheet metal screws or other suitable aluminum alloy or stainless steel fasteners. Drive fasteners in holes made with a No. 26 drill in securing side laps, end laps, and flashings. Space fasteners 12 inch maximum on center. Where end lap fasteners are required to improve closure, locate the end lap fasteners not more than 2 inch from the end of the overlapping sheet.

3.1.8 Protection from Contact with Dissimilar Materials

3.1.8.1 Aluminum

Do not allow aluminum surfaces in direct contact with other metals except stainless steel, zinc, or zinc coating. Where aluminum contacts another metal, paint the dissimilar metal with a primer followed by two coats of aluminum paint. Where drainage from a dissimilar metal passes over aluminum, paint the dissimilar metal with a non-lead pigmented paint.

3.1.8.2 Metal Surfaces

Paint surfaces in contact with mortar, concrete, or other masonry materials with alkali-resistant coatings such as heavy-bodied bituminous paint.

3.1.8.3 Wood or Other Absorptive Materials

Paint surfaces that may become repeatedly wet and in contact with metal with two coats of aluminum paint or a coat of heavy-bodied bituminous paint.

3.1.9 Expansion and Contraction

Provide expansion and contraction joints at not more than 32 foot intervals for aluminum. Provide an additional joint where the distance between the last expansion joint and the end of the continuous run is more than half the required interval. Space joints evenly. Join extruded aluminum sill flashings by expansion and contraction joints spaced not more than 12 feet apart.

3.1.10 Sheet Metal Covering on Flat, Sloped, or Curved Surfaces

Except as specified or indicated otherwise, cover and flash all minor flat, sloped, or curved surfaces such as crickets, bulkheads, dormers and small decks with metal sheets of the material used for flashing; maximum size of sheets, 16 by 18 inch. Fasten sheets to sheathing with metal cleats. Lock seams and solder. Lock aluminum seams as recommended by aluminum manufacturer. Provide an underlayment of roofing felt for all sheet metal covering.

## 3.2 PAINTING

Field-paint sheet metal for separation of dissimilar materials.

### 3.2.1 Aluminum Surfaces

Shall be solvent cleaned and given one coat of zinc-molybdate primer and one coat of aluminum paint.

## 3.3 CLEANING

Clean exposed sheet metal work at completion of installation. Remove grease and oil films, handling marks, contamination from steel wool, fittings and drilling debris, and scrub-clean. Free the exposed metal surfaces of dents, creases, waves, scratch marks, and solder or weld marks.

## 3.4 REPAIRS TO FINISH

Scratches, abrasions, and minor surface defects of finish may be repaired in accordance with the manufacturer's printed instructions and as approved. Repair damaged surfaces caused by scratches, blemishes, and variations of color and surface texture. Replace items which cannot be repaired.

## 3.5 FIELD QUALITY CONTROL

| TABLE I. SHEET METAL WEIGHTS, THICKNESSES, AND GAGES | |
|---|---|
| Sheet Metal Items | Aluminum, inch |
| Cover | .032 |
| Covering on minor flat, pitched or curved surfaces | .040 |
| Sheets, smooth | .050 |

| TABLE II. SHEET METAL JOINTS | | |
|---|---|---|
| TYPE OF JOINT | | |
| Item Designation | Aluminum | Remarks |
| Flashings | | |

| TABLE II. SHEET METAL JOINTS | | |
|---|---|---|
| TYPE OF JOINT | | |
| Item Designation | Aluminum | Remarks |
| Sill | One inch flat locked, soldered; sealed; 3 inch lap for expansion joint | Aluminum producer's recommended hard setting sealant for locked aluminum joints. Fill each metal expansion joint with a joint sealing compound compound. |
| Sheet, smooth | Butt with 1/4 inch space | Use sheet flashing backup plate. |

-- End of Section 07 60 00 --

SECTION 07 92 00
JOINT SEALANTS

## PART 1 GENERAL

### 1.1 REFERENCES

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

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM C920 | (2014a) Standard Specification for Elastomeric Joint Sealants |

### 1.2 SUBMITTALS

Contracting Officer's written approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Sealants

Primers

Bond breakers

Backstops

Manufacturer's descriptive data including storage requirements, shelf life, curing time, instructions for mixing and application, and primer data (if required). Provide a copy of the Material Safety Data Sheet for each solvent, primer or sealant material.

SD-07 Certificates

Warranty

Sealant

Certificates of compliance stating that the materials conform to the specified requirements.

### 1.3 ENVIRONMENTAL CONDITIONS

Apply sealant when the ambient temperature is between 40 and 90 degrees F.

## 1.4 DELIVERY AND STORAGE

Deliver materials to the job site in unopened manufacturers' external shipping containers, with brand names, date of manufacture, and material designation clearly marked thereon. Label elastomeric sealant containers to identify type, class, grade, and use. Carefully handle and store materials to prevent inclusion of foreign materials or subjection to sustained temperatures exceeding 90 degrees F or less than 0 degrees F.

## 1.5 QUALITY ASSURANCE

### 1.5.1 Compatibility with Substrate

Verify that each of the sealants are compatible for use with joint substrates.

### 1.5.2 Joint Tolerance

Provide joint tolerances in accordance with manufacturer's printed instructions.

## 1.6 WARRANTY

Guarantee sealant joint against failure of sealant and against water penetration through each sealed joint for five years.

# PART 2 PRODUCTS

## 2.1 SEALANTS

Provide sealant that has been tested and found suitable for the substrates to which it will be applied.

### 2.1.1 Interior Sealant

Provide ASTM C920, Type S or M, Grade NS, Class 12.5, Use NT. Location(s) and color(s) of sealant for the following:

| LOCATION | COLOR |
|---|---|
| a. Small voids between walls or partitions and adjacent lockers, casework, shelving, door frames, built-in or surface-mounted equipment and fixtures, and similar items. | White |
| b. Perimeter of frames at doors, windows, and access panels which adjoin exposed interior concrete and masonry surfaces. | White |

| LOCATION | COLOR |
|---|---|
| c. Joints of interior masonry walls and partitions which adjoin columns, pilasters, concrete walls, and exterior walls unless otherwise detailed. | White |
| d. Interior locations, not otherwise indicated or specified, where small voids exist between materials specified to be painted. | White |
| e. Joints between bathtubs and ceramic tile; joints between shower receptors and ceramic tile; joints formed where nonplaner tile surfaces meet. | White |
| f. Joints formed between tile floors and tile base cove; joints between tile and dissimilar materials; joints occurring where substrates change. | White |
| g. Behind escutcheon plates at valve pipe penetrations and showerheads in showers. | White |

2.1.2 Exterior Sealant

For joints in vertical surfaces, provide ASTM C920, Type S or M, Grade NS, Class 25, Use NT. For joints in horizontal surfaces, provide ASTM C920, Type S or M, Grade P, Class 25, Use T. Provide location(s) and color(s) of sealant as follows:

| LOCATION | COLOR |
|---|---|
| a. Joints and recesses formed where frames and subsills of windows, doors, louvers, and vents adjoin masonry, concrete, or metal frames. Use sealant at both exterior and interior surfaces of exterior wall penetrations. | Match adjacent surface color |
| b. Masonry joints where shelf angles occur. | Match adjacent surface color |
| c. Control joints. | Match adjacent surface color |
| d. Voids where items pass through exterior walls. | Match adjacent surface color |
| e. Metal-to-metal joints where sealant is indicated or specified. | Match adjacent surface color |

2.1.3 Floor Joint Sealant

ASTM C920, Type S or M, Grade P, Class 25, Use T. Provide location(s) and color(s) of sealant as follows:

| LOCATION | COLOR |
|---|---|
| a. Seats of metal thresholds for exterior doors. | Gray |
| b. Control and expansion joints in floors, slabs, ceramic tile, and walkways. | Gray |

## 2.2 PRIMERS

Provide a nonstaining, quick-drying type and consistency recommended by the sealant manufacturer for the particular application.

## 2.3 BOND BREAKERS

Provide the type and consistency recommended by the sealant manufacturer to prevent adhesion of the sealant to backing or to bottom of the joint.

## 2.4 BACKSTOPS

Provide glass fiber roving or neoprene, butyl, polyurethane, or polyethylene foams free from oil or other staining elements as recommended by sealant manufacturer. Provide 25 to 33 percent oversized backing for closed cell and 40 to 50 percent oversized backing for open cell material, unless otherwise indicated. Make backstop material compatible with sealant. Do not use oakum and other types of absorptive materials as backstops.

## 2.5 CLEANING SOLVENTS

Provide type(s) recommended by the sealant manufacturer except for aluminum and bronze surfaces that will be in contact with sealant.

# PART 3 EXECUTION

## 3.1 SURFACE PREPARATION

Clean surfaces from dirt frost, moisture, grease, oil, wax, lacquer, paint, or other foreign matter that would tend to destroy or impair adhesion. Remove oil and grease with solvent. Surfaces must be wiped dry with clean cloths. When resealing an existing joint, remove existing caulk or sealant prior to applying new sealant. For surface types not listed below, contact sealant manufacturer for specific recommendations.

3.1.1 Steel Surfaces

Remove loose mill scale by sandblasting or, if sandblasting is impractical or would damage finish work, scraping and wire brushing. Remove protective coatings by sandblasting or using a residue-free solvent.

3.1.2 Aluminum or Bronze Surfaces

Remove temporary protective coatings from surfaces that will be in contact with sealant. When masking tape is used as a protective coating, remove tape and any residual adhesive just prior to sealant application. For removing protective coatings and final cleaning, use nonstaining solvents recommended by the manufacturer of the item(s) containing aluminum or bronze surfaces.

3.1.3 Concrete and Masonry Surfaces

Where surfaces have been treated with curing compounds, oil, or other such materials, remove materials by sandblasting or wire brushing. Remove laitance, efflorescence and loose mortar from the joint cavity.

3.2 SEALANT PREPARATION

Do not add liquids, solvents, or powders to the sealant. Mix multicomponent elastomeric sealants in accordance with manufacturer's instructions.

3.3 APPLICATION

3.3.1 Joint Width-To-Depth Ratios

a. Acceptable Ratios:

| JOINT WIDTH | JOINT DEPTH | |
|---|---|---|
| | Minimum | Maximum |
| For metal, or other nonporous surfaces: | | |
| 1/4 inch (minimum) | 1/4 inch | 1/4 inch |
| over 1/4 inch | 1/2 of width | Equal to width |
| For concrete or masonry: | | |
| 1/4 inch (minimum) | 1/4 inch | 1/4 inch |
| over 1/4 inch to 1/2 inch | 1/4 inch | Equal to width |
| over 1/2 inch to 2 inch | 1/2 inch | 5/8 inch |

| | |
|---|---|
| Over 2 inch | As recommended by sealant manufacturer |

b. Unacceptable Ratios: Where joints of acceptable width-to-depth ratios have not been provided, clean out joints to acceptable depths and grind or cut to acceptable widths without damage to the adjoining work. Grinding is not required on metal surfaces.

3.3.2 Masking Tape

Place masking tape on the finish surface on one or both sides of a joint cavity to protect adjacent finish surfaces from primer or sealant smears. Remove masking tape within 10 minutes after joint has been filled and tooled.

3.3.3 Backstops

Install backstops dry and free of tears or holes. Tightly pack the back or bottom of joint cavities with backstop material to provide a joint of the depth specified. Install backstops in the following locations:

a. Where indicated.

b. Where backstop is not indicated but joint cavities exceed the acceptable maximum depths specified in paragraph entitled, "Joint Width-to-Depth Ratios".

3.3.4 Primer

Immediately prior to application of the sealant, clean out loose particles from joints. Where recommended by sealant manufacturer, apply primer to joints in concrete masonry units, wood, and other porous surfaces in accordance with sealant manufacturer's instructions. Do not apply primer to exposed finish surfaces.

3.3.5 Bond Breaker

Provide bond breakers to the back or bottom of joint cavities, as recommended by the sealant manufacturer for each type of joint and sealant used, to prevent sealant from adhering to these surfaces. Carefully apply the bond breaker to avoid contamination of adjoining surfaces or breaking bond with surfaces other than those covered by the bond breaker.

3.3.6 Sealants

Provide a sealant compatible with the material(s) to which it is applied. Do not use a sealant that has exceeded shelf life or has jelled and can not be discharged in a continuous flow from the gun. Apply the sealant in accordance with the manufacturer's printed instructions with a gun having a nozzle that fits the joint width. Force sealant into joints to fill the joints solidly without air pockets. Tool sealant after application to ensure adhesion. Make sealant uniformly smooth and free of wrinkles. Upon completion of sealant application, roughen partially filled or unfilled

joints, apply sealant, and tool smooth as specified. Apply sealer over the sealant when and as specified by the sealant manufacturer.

## 3.4 PROTECTION AND CLEANING

### 3.4.1 Protection

Protect areas adjacent to joints from sealant smears. Masking tape may be used for this purpose if removed 5 to 10 minutes after the joint is filled.

### 3.4.2 Final Cleaning

Upon completion of sealant application, remove remaining smears and stains and leave the work in a clean and neat condition.

a. Masonry and Other Porous Surfaces: Immediately scrape off fresh sealant that has been smeared on masonry and rub clean with a solvent as recommended by the sealant manufacturer. Allow excess sealant to cure for 24 hour then remove by wire brushing or sanding.

b. Metal and Other Non-Porous Surfaces: Remove excess sealant with a solvent-moistened cloth.

-- End of Section 07 92 00 --

SECTION 08 22 20
FIBERGLASS REINFORCED PLASTIC (FRP) DOORS AND FRAMES

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

| | |
|---|---|
| ASCE 7 | (2010; Errata 2011; Supp 1 2013) Minimum Design Loads for Buildings and Other Structures |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM D2344/D2344M | (2013) Standard Test Method for Short-Beam Strength of Polymer Matrix Composite Materials and Their Laminates |
| ASTM D256 | (2010) Determining the Izod Pendulum Impact Resistance of Plastics |
| ASTM D638 | (2010) Standard Test Method for Tensile Properties of Plastics |
| ASTM D695 | (2010) Standard Test Method for Compressive Properties of Rigid Plastics |
| ASTM D696 | (2008; E 2013) Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between -30 degrees C and 30 degrees C With a Vitreous Silica Dilatometer |
| ASTM D790 | (2010) Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials |
| ASTM E1300 | (2012a; E 2012) Determining Load Resistance of Glass in Buildings |
| ASTM E2112 | (2007) Standard Practice for Installation of Exterior Windows, Doors and Skylights |
| ASTM E283 | (2004; R 2012) Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen |

| | |
|---|---|
| ASTM E331 | (2000; R 2009) Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference |
| ASTM E84 | (2014) Standard Test Method for Surface Burning Characteristics of Building Materials |
| ASTM F1642 | (2012) Standard Test Method for Glazing and Glazing Systems Subject to Airblast Loadings |
| ASTM F2248 | (2012) Standard Practice for Specifying an Equivalent 3-Second Duration Design Loading for Blast Resistant Glazing Fabricated with Laminated Glass |

BUILDERS HARDWARE MANUFACTURERS ASSOCIATION (BHMA)

| | |
|---|---|
| ANSI/BHMA A156.115 | (2006) Hardware Preparation in Steel Doors and Steel Frames |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 241 | (2013) Standard for Safeguarding Construction,Alteration, and Demolition Operations |

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

| | |
|---|---|
| 29 CFR 1910 | Occupational Safety and Health Standards |
| 29 CFR 1926 | Safety and Health Regulations for Construction |

1.2 SUBMITTALS

Contracting Officer's written approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Doors

Frames

SD-03 Product Data

Doors

Calculations

Frames

Insulation Materials

SD-07 Certificates

Warranty

## 1.3 DELIVERY, STORAGE, AND HANDLING

### 1.3.1 Delivery

Deliver FRP doors, frames, components and accessories in manufacturer's original unopened packaging. Mark and remove damaged materials from the project site. Where materials are covered by a referenced specification, label the package with the specification number, type, and class, as applicable. Deliver materials in sufficient quantity to allow work to proceed without interruption.

### 1.3.2 Storage

Protect materials against moisture absorption and contamination or other damage.

Store all materials on clean raised platforms or pallets one level high in dry locations with adequate ventilation, such as an enclosed building or closed trailer.

Do not store materials in buildings under construction until concrete, mortar, and plaster work is finished and dry.

Do not store materials outdoors unless approved by the Contracting Officer. Completely cover materials stored outdoors, on and off roof, with waterproof canvas protective covering. Do not use polyethylene sheet as a covering. Tie covering securely to pallets to make completely weatherproof. Provide sufficient ventilation to prevent condensation.

Do not store materials in contact with other materials that might cause staining, denting, or other surface damage.

### 1.3.3 Handling

Prevent damage to corners, edges and ends of materials. Do not install damaged materials in the work. Select and operate material handling equipment to prevent damage to materials.

## 1.4 EXISTING CONDITIONS

### 1.4.1 Field Measurements

Take Field measurements prior to the preparation of drawings and fabrication.

## 1.5 SAMPLE WARRANTY

Submit sample material and workmanship warranties meeting specified requirements. Provide revision or amendment to standard manufacturer warranty as required to comply with the specified requirements.

Furnish the manufacturer's 10 year no dollar limit for materials and installation, workmanship, and deterioration of factory-applied finishes within specified warranty period. Provide warranty directly to the Government and commence warranty effective date at time of Government's acceptance of the work.

# PART 2 PRODUCTS

## 2.1 SYSTEM DESCRIPTION

Provide door and frame components including, but not limited to, astragals, cores, faces, stiles, rails, heads, jambs, and internal reinforcement, which are FRP structural shapes manufactured by the pultrusion process. Ensure all structural shapes are composed of fiberglass reinforcement and resin in qualities, quantities, properties, arrangements and dimensions as necessary to meet the design requirements in accordance with ASCE 7, and dimensions specified.

Ensure fiberglass reinforcements are a combination of continuous roving, continuous strand mat, and surfacing veil in sufficient quantities as needed by the application and/or physical properties required.

Verify resins are of isophthalic polyester with chemical formulation necessary for corrosion resistance, strength and other physical properties as required.

### 2.1.1 Finish Surfaces

Ensure all finished surfaces of FRP items and fabrications are smooth, resin-rich, free of voids and without dry spots, cracks, and un-reinforced areas. Completely cover all glass fibers with resin to protect against their exposure due to wear or weathering. All stiles, rails, heads, jambs, and internal reinforcement are to be integrally pigmented yellow.

### 2.1.2 Ultraviolet Protection

Provide documentation that all pultruded structural shapes are further protected from ultraviolet (UV) attack with:

a. Integral UV inhibitors within the resin

b. Synthetic surfacing veil to help produce a resin rich surface

c. UV resistant coating for outdoor exposures.

2.1.3 Flame Spread Rating

All FRP products to have a flame spread rating of 25 or less as per ASTM E84Tunnel Test.

2.1.4 Structural Properties

Meet minimum longitudinal structural properties with structural shapes in the door and frame system as follows:

| | | |
|---|---|---|
| Tensile Strength: | ASTM D638 | 30,000 psi |
| Compressive Strength: | ASTM D695 | 30,000 psi |
| Flexural Strength: | ASTM D790 | 30,000 psi |
| Flexural Modulus: | ASTM D790 | 1,600,000 psi |
| Short Beam Shear: | ASTM D2344/D2344M | 4,500 psi |
| Impact, Notched: | ASTM D256 | 25 ft-lb/in |
| Thermal Expansion: | ASTM D696 | .000008 in/in/F |
| Fire Resistance: | ASTM E84 | Class I |

2.2 DESIGN REQUIREMENTS

2.2.1 FRP Door and Frame

Provide complete swing-type FRP doors with frames of the size, design and location indicated, including but not limited to, framing members, subframes, door light, trim, and accessories.

Provide complete door hardware schedule, design and location as specified in specification Section 08 71 00 DOOR HARDWARE.

Provide complete door glazing schedule, design and location as specified in specification Section 08 81 00 GLAZING.

2.2.1.1 FRP Door

Provide and install a seamless press-molded constructed FRP door. Laminate FRP face sheets to be applied while wet and uncured to an internal door stile and rail subframe/core assembly which

is pressure molded under heat. Integrally fuse the composite door panel over the entire surface area, do not adhesive-bond at the perimeter stile and rail.

Provide door stiles and rails which are high-modulus pultruded FRP square or rectangular tube subframe. Miter and join tubes internally at the corners with solid polymer blocks to yield a one piece unit. Provide a mid-rail tube across the width of the door at lockset height and additional horizontal rails where specified. Chemically weld all connections. No mechanical fastening at to tube joints is permitted.

Provide a triangular shaped 3/8 inch phenolic resin impregnated kraft paper honeycomb cell core for maximum rigidity and compressive strength. Use polyurethane foam or balsa wood cores are not permitted.

Provide internal reinforcement composed of high-modulus pultruded tubular FRP or high-density polymer compression blocks at all hardware and corner locations. No aluminum, steel, or wood blocking for reinforcement is permitted. A minimum pull-out force strength of 900 lbs per screw is required for all hinge locations.

Door faces are to utilize a chemical resistant thermosetting polyester resin with fiberglass reinforcing layers. Provide structural reinforcement which is knitted multi-layer material with layers of unidirectional fiberglass orientated in both vertical and horizontal directions for high stiffness, impact and warp resistance. Furnish door faces as indicated by the door elevation drawings.

The exposed finish of the FRP door faces are to be an ultra-violet light stabilized marine grade Neopentyl Glychol (NPG)-isophthalic polyester gelcoat integrally molded to a 25/30 mil wet thickness.

Cutouts for door lights are to be manufactured and not field fabricated. Cutouts are to be totally enclosed by internal pultruded FRP stiles and rails as specified and incorporated into the door subframe with the opening completely fused to both door faces.

2.2.1.2 FRP Frame

Provide a FRP Door Frame utilizing a high-modulus pultruded structural FRP shape. Fabricate pultruded frame with a wall thickness of not less than 3/16 inch. Frames are to be one piece factory constructed with molded stop. Jambs and header to utilizing miter corner connections chemically weld with FRP material ground for a visibly smooth frame face. Post and beam or mechanical fastened corners and joints are not acceptable. Provide sizes and shapes as detailed on the approved drawings.

Provide hardware reinforcement connections utilizing a chemical weld with FRP material at required locations. A minimum pull-out force strength of 1,100 lbs per screw is required for all hardware locations.

Frame finish is to be identical to door color and finish. Integrally mold a 25 wet mil resin rich gel coat into the frame during manufacturing.

2.2.2 Frame Anchors

Provide anchorage devices and fasteners where necessary for fastening fabricated FRP door frame to the adjacent construction-in-place as recommended by the FRP frame manufacturer.

2.2.3 Jamb Anchors

Provide Masonry Anchors of hot-dip galvanized steel minimum of 18 gauge thick, type, number, and spacing as required by the FRP frame manufacturer.

Provide hot-dip galvanized steel Stud-Wall Type anchors design to engage the wall framing; not less than 18 gauge thick.

2.3 HARDWARE PREPARATION

Provide hardware reinforcing as specified. Prepare doors and frames for hardware in accordance with the applicable requirements of FRP door and frame manufacturer. For additional requirements refer to ANSI/BHMA A156.115.

2.4 PERFORMANCE REQUIREMENTS

2.4.1 Structural

Design exterior doors, frames and hardware to resist equivalent static design loads in accordance with ASTM F1642, with frame deflections not to exceed L/160 of the unsupported member lengths. Use equivalent static design loads for connections of the door frame to the surrounding walls or hardware and associated connections, in accordance with ASTM F2248 and ASTM E1300. Design supporting elements and their connections based on their ultimate capacities. Provide calculations prepared by a Professional Engineer that substantiates compliance with these requirements, including insulation materials. Use frames that provide an equivalent level of performance. Provide framing members with shape and thickness sufficient to withstand the design wind load indicated with a deflection of not more than 1/175 times the length of the member and a safety factor of not less than 1.65. Provide glazing beads, moldings, and trim of not less than 0.050 inch nominal thickness.

2.4.2 Air Infiltration

When tested in accordance with ASTM E283, air infiltration is not to exceed 0.06 cubic feet per minute per square footof fixed area at a test pressure of 6.24 pounds per square foot 50 mile per hour wind.

2.4.3 Water Penetration

When tested in accordance with ASTM E331, no water penetration is allowed, at a pressure of 8 pounds per square foot of fixed area.

2.4.4 Provisions for Thermal Movement

Design doors and frames to provide for expansion and contraction of the component parts caused by an ambient temperature range of 0 to 100 degrees F causing buckling, opening of joints, overstressing of fasteners, or other harmful effects.

PART 3 EXECUTION

3.1 INSTALLATION

Conform all work to the requirements of 29 CFR 1910, 29 CFR 1926, and NFPA 241.

3.1.1 FRP Frame

Set FRP door frame plumb and true, aligned, and secured with the adjacent construction-in-place, in conformance with ASTM E2112. Anchor frame as specified and in accordance with the FRP door manufacturer's requirements.

Installation Tolerances

a. Squareness: Plus or minus 1/16 inch, measure at the door rabbet on a line 90 degrees from the jamb perpendicular to the frame head.

b. Alignment: Plus or minus 1/16 inch, measure at the jamb on a horizontal line parallel to the wall plane.

c. Twist: Plus or minus 1/16 inch, measure at the opposite face corners of the jambs on parallel lines, and perpendicular to the wall plane.

d. Plumb and True: Plus or minus 1/16 inch, measure at the jambs to the floor.

3.1.2 FRP Door

Fit and hang door in accordance with clearances specified below:

Clearance Tolerances

a. Jambs and Head: Plus 1/8 inch or minus 1/16 inch.

b. Pairs of Doors: Plus 1/8 inch or minus 1/16 inch.

c. Bottom of Door and Top of Threshold: Maximum 3/8 inch.

d. Bottom of Door and Top of finish floor (No Threshold: Maximum 3/4 inch.

## 3.2 PROTECTION

Protect doors and frames from damage. Repair damaged doors and frames prior to final completion and acceptance of the project or replace with new, as directed by the Contracting Officer. Thoroughly clean all surfaces of the door and frame prior to final completion and acceptance of the project.

## 3.3 ADJUSTMENT

Check and re-adjust all operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including all FRP that is warped, bowed, or otherwise unacceptable to the Contracting Officer's Representative.

## 3.4 STANDARD WARRANTY

Submit approved Standard Warranty made out to the Government, to the Contracting Officer no later than 10 days prior to final inspection,

-- End of Section 08 22 20 --

SECTION 08 33 23
OVERHEAD COILING DOORS

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

| | |
|---|---|
| ASCE 7 | (2010; Errata 2011; Supp 1 2013) Minimum Design Loads for Buildings and Other Structures |

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

| | |
|---|---|
| ASHRAE FUN IP | (2013) Fundamentals Handbook, I-P Edition |

ASME INTERNATIONAL (ASME)

| | |
|---|---|
| ASME B29.400 | (2001; R 2013) Combination, "H" Type Mill Chains, and Sprockets |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A153/A153M | (2009) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware |
| ASTM A27/A27M | (2013) Standard Specification for Steel Castings, Carbon, for General Application |
| ASTM A307 | (2012) Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength |
| ASTM A36/A36M | (2012) Standard Specification for Carbon Structural Steel |
| ASTM A48/A48M | (2003; R 2012) Standard Specification for Gray Iron Castings |
| ASTM A53/A53M | (2012) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless |

| | |
|---|---|
| ASTM A653/A653M | (2013) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process |
| ASTM A666 | (2010) Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate and Flat Bar |
| ASTM A780/A780M | (2009) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings |
| ASTM A924/A924M | (2013) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process |
| ASTM B209 | (2010) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate |
| ASTM B221 | (2013) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes |
| ASTM D2000 | (2012) Standard Classification System for Rubber Products in Automotive Applications |
| ASTM E330 | (2002; R 2010) Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference |
| ASTM E84 | (2014) Standard Test Method for Surface Burning Characteristics of Building Materials |
| ASTM F568M | (2007) Standard Specification for Carbon and Alloy Steel Externally Threaded Metric Fasteners |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| NEMA ICS 2 | (2000; R 2005; Errata 2008) Standard for Controllers, Contactors, and Overload Relays Rated 600 V |
| NEMA ICS 6 | (1993; R 2011) Enclosures |
| NEMA MG 1 | (2011; Errata 2012) Motors and Generators |
| NEMA ST 1 | (1988; R 1994; R 1997) Specialty Transformers (Except General Purpose Type) |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 70 | (2014; AMD 1 2013; Errata 1 2013; AMD 2 2013; Errata 2 2013; AMD 3 2014; Errata 3 2014) National Electrical Code |

1.2 SUBMITTALS

Contracting Officer's written approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Overhead Coiling Doors

Counterbalancing Mechanism

Electric Door Operators

Bottom Bars

Guides

Mounting Brackets

Overhead Drum

Hood

Installation Drawings

SD-03 Product Data

Overhead Coiling Doors

Hardware

Counterbalancing Mechanism

Electric Door Operators

SD-05 Design Data

Overhead Coiling Doors

Hardware

Counterbalancing Mechanism

Electric Door Operators

SD-07 Certificates

Warranty

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals

Materials

Devices

Procedures

Manufacture's Brochures

Parts Lists

Cleaning

## 1.3 OVERHEAD COILING DOOR DETAIL SHOP DRAWINGS

Provide installation drawings for overhead coiling door assemblies which show: elevations of each door type, shape and thickness of materials, finishes, details of joints and connections, details of guides and fittings, rough opening dimensions, location and description of hardware, anchorage locations, and counterbalancing mechanism and door operator details. Show locations of replaceable fusible links on wiring diagrams for power, signal and controls. Include a schedule showing the location of each door with the drawings.

## 1.4 STANDARD WARRANTY, OPERATION AND MAINTENANCE DATA

Submit Operation and Maintenance Manuals for Overhead Coiling Door Assemblies, including the following items:

Materials

Devices

Electric Door Operators

Hood

Counterbalancing Mechanism

Procedures

Manufacture's Brochures

Parts Lists

Furnish a written guarantee that the helical spring and counterbalance mechanism are free from defects in material and workmanship for not less than two years after completion and acceptance of the project.

Warrant that upon notification by the Government, any defects in material, workmanship, and door operation are immediately correct within the same time period covered by the guarantee, at no cost to the Government.

## 1.5 DELIVERY AND STORAGE

Deliver doors to the jobsite wrapped in a protective covering with the brands and names clearly marked thereon. Store doors in an adequately ventilated dry location that is free from dirt and dust, water, or other contaminants. Store in a manner that permits easy access for inspection and handling.

# PART 2 PRODUCTS

## 2.1 DESCRIPTION

Doors to be coiling type, with insulated interlocking slats, complete with anchoring and door hardware, guides, hood, and operating mechanisms, and designed for use on openings as indicated. Use grease-sealed or self-lubricating bearings for rotating members.

## 2.2 PERFORMANCE REQUIREMENTS

### 2.2.1 Wind Loading

Design and fabricate door assembly to withstand the wind loading pressure of at least 110 pounds per square foot with a maximum deflection of 1/120 of the opening width. Provide test data showing compliance with ASTM E330. Sound engineering principles may be used to interpolate or extrapolate test results to door sizes not specifically tested. Ensure complete assembly meets or exceeds the requirements of ASCE 7.

### 2.2.2 Operational Cycle Life

Design all portions of the door, hardware and operating mechanism that are subject to movement, wear, or stress fatigue to operate through a minimum number of 10 cycles per day.

One complete cycle of door operation is defined as when the door is in the closed position, moves to the fully open position, and returns to the closed position.

## 2.3 OVERHEAD COILING DOORS

### 2.3.1 Curtain Materials and Construction

Provide curtain slats fabricated from aluminum sheets conforming to ASTM B209, or ASTM B221 extrusions, alloy and tempering standard from manufacturer for type of use and finish indicated; with a thickness of 0.050 inch.

Fabricate doors from interlocking cold-rolled slats, with section profiles as specified, designed to withstand the specified wind loading. Ensure the provided slats are continuous without splices for the width of the door.

Provide slats filled with manufacturer's standard thermal insulation complying with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, according to ASTM E84. Enclose insulation completely within slat faces on interior surface of slats.

### 2.3.2 Insulated Curtains

Form Curtains from manufacturer's standard shapes of interlocking slats. Supply slat system with a minimum R-value of 7 when calculated in accordance with ASHRAE FUN IP. Slats to consist of a polyurethane core not less than 11/16 inch thick, completely enclosed within metal facings. Ensure the exterior face of slats are the same gauge as specified for curtains. Select an interior face not lighter than 0.0219 inches. The insulated slat assembly requires a flame spread rating of not more than 25 and a smoke development factor of not more than 50 when tested in accordance with ASTM E84.

### 2.3.3 Curtain Bottom Bar

Install curtain bottom bars as pairs of angles from the manufacturer's standard steel, stainless and aluminum extrusions not less than 2.0 by 2.0 inches by 0.188 inch. Ensure steel extrusions conform to ASTM A36/A36M. Stainless steel extrusions conforming to ASTM A666, Type 304. Aluminum extrusions conforming to ASTM B221. Galvanize angles and fasteners in accordance with ASTM A653/A653M and ASTM A924/A924M. Coat welds and abrasions with paint conforming to ASTM A780/A780M.

### 2.3.4 Vision Panels

Provide complete manufacturer's standard vision panels assembly consisting of clear acrylic glazing panels or fire-rated glass as required for the type door. Set panels in a neoprene channel with a galvanized-steel frame not less than 0.0359-inch uncoated thickness.

### 2.3.5 Locks

Provide end and/or wind locks of Grade B cast steel conforming to ASTM A27/A27M, galvanized in accordance with ASTM A653/A653M, ASTM A153/A153M and ASTM A924/A924M. Secure locks at every other curtain slat.

### 2.3.6 Weather Stripping

Ensure weather-stripping at the door-head and jamb is 1/8-inch thick sheet of natural or neoprene rubber with air baffles. Secure weather stripping to the insides of hoods with galvanized-steel fasteners through continuous galvanized-steel pressure bars at least 5/8-inch wide and 1/8-inch thick.

Ensure threshold weather-stripping is 1/8-inch thick sheet natural or neoprene rubber secured to the bottom bars.

Provide weather-stripping of natural or neoprene rubber conforming to ASTM D2000.

### 2.3.7 Locking Devices

Ensure slide bolt engages through slots in tracks for locking by padlock, located on both left and right jamb sides, operable from coil side.

Provide a locking device assembly which includes cylinder lock, spring-loaded dead bolt, operating handle, cam plate, and adjustable locking bars to engage through slots in tracks.

### 2.3.8 Safety Interlock

Equip power-operated doors with safety interlock switch to disengage power supply when door is locked.

### 2.3.9 Overhead Drum

Fabricate drums from nominal 0.040-inch thick aluminum sheet complying with ASTM B209. Aluminum of alloy and temper recommended by manufacturer. Select finish for type of use and finish indicated.

## 2.4 HARDWARE

Ensure all hardware conforms to ASTM A153/A153M, ASTM A307, ASTM F568M, and ASTM A27/A27M.

### 2.4.1 Guides

Fabricate curtain jamb guides from the manufacturer's standard angles or channels of same material and finish as curtain slats unless otherwise indicated. Provide guides with sufficient depth and strength to retain curtain, and to withstand loading. Ensure curtain operates smoothly. Slot bolt holes for track adjustment.

Fabricate with aluminum angles. Provide windlock bars of same material when windlocks are required to meet specified wind load. Flare the top of inner and outer guide angles outwards to form bellmouth for smooth entry of curtain into guides. Provide removable guide stoppers to prevent over travel of curtain and bottom bar.

2.4.2 Equipment Supports

Fabricate door-operating equipment supports from the manufacturer's standard steel shapes and plates conforming to ASTM A36/A36M, galvanized in accordance with ASTM A653/A653M and ASTM A924/A924M. Size the shapes and plates in accordance with the industry standards for the size, weight, and type of door installation.

2.4.3 Hood

Provide a hood with a minimum aluminum 22-gauge B&S sheet metal, flanged at top for attachment to header and flanged at bottom to provide longitudinal stiffness. The hood encloses the curtain coil and counterbalance mechanism.

Provide a 0.040 inch aluminum hood with reinforced top and bottom edges. Provide minimum 1/4 inch steel intermediate support brackets as required to prevent excessive sag.

2.5 COUNTERBALANCING MECHANISM

Counterbalance doors by means of manufacturer's standard mechanism with an adjustable-tension, steel helical torsion spring mounted, around a steel shaft and contained in a spring barrel connected to top of curtain with barrel rings. Use grease-sealed or self-lubricating bearings for rotating members.

2.5.1 Brackets

Provide the manufacturer's standard mounting brackets with one located at each end of the counterbalance barrel conforming to ASTM A48/A48M. Provide brackets of either cast iron or cold-rolled steel.

Brackets will be of 3/16 inch minimum thick steel plates, with permanently sealed ball bearings. Designed to enclose ends of coil and provide support of counterbalance pipe at each end.

2.5.2 Counterbalance Barrels

Fabricate spring barrel of manufacturer's standard hot-formed, structural-quality, welded or seamless carbon-steel pipe, conforming to ASTM A53/A53M. Ensure the barrel is of sufficient diameter and wall thickness to support rolled-up curtain without distortion of slats. Limit barrel deflection to not more than 0.03 inch per foot of span under full load.

2.5.2.1 Barrel

Provide steel pipe capable of supporting curtain load with maximum deflection of 0.03 inches per foot of width.

## 2.6 ELECTRIC DOOR OPERATORS

Provide electrical wiring and door operating controls conforming to the applicable requirements of NFPA 70.

Electric door-operator assemblies needs to be the sizes and capacities recommended and provided by the door manufacturer for specified doors. Furnish complete assemblies with electric motors and factory-prewired motor controls, starter, gear reduction units, solenoid-operated brakes, clutch, remote-control stations, manual or automatic control devices, and accessories as required for proper operation of the doors.

Design the operators so that motors may be removed without disturbing the limit-switch adjustment and affecting the emergency auxiliary operators.

Provide a manual operator of crank-gear or chain-gear mechanisms with a release clutch to permit manual operation of doors in case of power failure. Arrange the emergency manual operator so that it may be put into and out of operation from floor level, and its use does not affect the adjustment of the limit switches. Provide an electrical or mechanical device that automatically disconnects the motor from the operating mechanism when the emergency manual operating mechanism is engaged.

### 2.6.1 Door-Operator Types

Provide an operator mounted to the right or left door head plate with the operator on top of the door-hood assembly and connected to the door drive shaft with drive chain and sprockets. Headroom is required for this type of mounting.

### 2.6.2 Electric Motors

Provide motors which are the high-starting-torque, reversible, constant-duty electrical type with overload protection of sufficient torque and horsepower to move the door in either direction from any position. Ensure they produce a door-travel speed of not less than 8 nor more than 12 inches per second without exceeding the horsepower rating.

Provide motors which conform to NEMA MG 1 designation, temperature rating, service factor, enclosure type, and efficiency to the requirements specified.

### 2.6.3 Motor Bearings

Select bearings with bronze-sleeve or heavy-duty ball or roller antifriction type with full provisions for the type of thrust imposed by the specific duty load.

Equip motors coupled to worm-gear reduction units with either ball or roller bearings.

Equip bearings in motors 1/2 horsepower or larger with lubrication service fittings. Fit lubrication fittings with color-coded plastic or metal dust caps.

In any motor, bearings that are lubricated at the factory for extended duty periods do not need to be lubricated for a given number of operating hours. Display this information on an appropriate tag or label on the motor with instructions for lubrication cycle maintenance.

2.6.4 Motor Starters, Controls, and Enclosures

Provide each door motor with: a factory-wired, unfused, disconnect switch; a reversing, across-the-line magnetic starter with thermal overload protection; 120-volt operating coils with a control transformer limit switch; and a safety interlock assembled in a NEMA ICS 6 type enclosure as specified herein. Ensure control equipment conforms to NEMA ICS 2.

Provide adjustable switches, electrically interlocked with the motor controls and set to stop the door automatically at the fully open and fully closed position.

2.6.5 Control Enclosures

Provide control enclosures that conform to NEMA ICS 6 for general purpose NEMA Type 1.

2.6.6 Transformer

Provide starters with 230/460 to 115 volt control transformers with one secondary fuse when required to reduce the voltage on control circuits to 120 volts or less. Provide a transformer conforming to NEMA ST 1.

2.6.7 Safety-Edge Device

Provide each door with a pneumatic safety device extending the full width of the door and located within a U-section neoprene or rubber astragal, mounted on the bottom rail of the bottom door section. Device needs to immediately stop and reverse the door upon contact with an obstruction in the door opening during downward travel and cause the door to return to full-open position. A safety device is not a substitute for a limit switch.

Connect safety device to the control circuit through a retracting safety cord and reel.

2.6.8 Remote-Control Stations

Provide interior remote control stations which are full-guarded, momentary-contact three-button, heavy-duty, surface-mounted NEMA ICS 6 type enclosures as specified. Mark buttons "OPEN," "CLOSE," and "STOP." Ensure the "CLOSE" button requires a constant pressure to maintain the closing motion of the door. When the door is in motion and the "STOP" button is pressed,

ensure the door stops instantly and remains in the stopped position. From the stopped position, the door may then be operated in either direction.

Provide exterior control stations which are full-guarded, momentary-contact three-button standard-duty, surface-mounted, weatherproof type, NEMA ICS 6, Type 4 enclosures, key-operated, with the same operating functions as specified herein for interior remote-control stations.

2.6.9 Speed-Reduction Units

Provide speed-reduction units consisting of hardened-steel worm and bronze worm gear assemblies running in oil or grease and inside a sealed casing, coupled to the motor through a flexible coupling. Drive shafts need to rotate on ball- or roller-bearing assemblies that are integral with the unit.

Provide minimum ratings of speed reduction units in accordance with AGMA provisions for class of service.

Ground worm gears to provide accurate thread form; machine teeth for all other types of gearing. Surface harden all gears.

Provide antifriction type bearings equipped with oil seals.

2.6.10 Chain Drives

Provide roller chains that are a power-transmission series steel roller type conforming to ASME B29.400, with a minimum safety factor of 10 times the design load.

Heat-treat or otherwise harden roller-chain side bars, rollers, pins, and bushings.

Provide high-carbon steel chain sprockets with machine-cut hardened teeth, finished bore and keyseat, and hollow-head setscrews.

2.6.11 Brakes

Provide 360-degree shoe brakes or shoe and drum brakes. Ensure the brakes are solenoid-operated and electrically interlocked to the control circuit to set automatically when power is interrupted.

2.6.12 Clutches

Ensure clutches are either the 4-inch diameter, multiple face, externally adjustable friction type or adjustable centrifugal type.

2.6.13 Weather/Smoke Seal Sensing Edge

Provide automatic stop control by an automatic sensing switch within neoprene astragal extending the full width of door bottom bar.

Provide an electric sensing edge device. Ensure the door immediately stops downward travel when contact occurs before door fully closes. Provide a self-monitoring wireless sensing edge connection to the motor operator; eliminating the need for a physical traveling electric cord connection between bottom bar sensing edge device and motor operator. Supervised system alters normal door operation; preventing damage, injury or death due to an inoperable sensing edge system.

## 2.7 SURFACE FINISHING

Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes. Noticeable variations in the same metal component are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved samples and are assembled or installed to minimize contrast.

# PART 3 EXECUTION

## 3.1 GENERAL

Install overhead coiling door assembly, anchors and inserts for guides, brackets, motors, switches, hardware, and other accessories in accordance with approved detail drawings and manufacturer's written instructions. Upon completion of installation, ensure doors are free from all distortion.

Install overhead coiling doors, motors, hoods, and operators at the mounting locations as indicated for each door in the contract documents and as required by the manufacturer.

Install overhead coiling doors, switches, and controls along accessible routes in compliance with regulatory requirements for accessibility and as required by the manufacturer.

## 3.2 ACCEPTANCE PROVISIONS

After installation, adjust hardware and moving parts. Lubricate bearings and sliding parts as recommended by manufacturer to provide smooth operating functions for ease movement, free of warping, twisting, or distortion of the door assembly.

Adjust seals to provide weather-tight fit around entire perimeter.

Engage a factory-authorized service representative to perform startup service and checks according to manufacturer's written instructions.

Test the door opening and closing operation when activated by controls or alarm-connected fire-release system. Adjust controls and safeties. Replace damaged and malfunctioning controls and equipment. Reset door-closing mechanism after successful test.

Test and make final adjustment of new doors at no additional cost to the Government.

### 3.2.1 Maintenance and Adjustment

Not more than 90 calendar days after completion and acceptance of the project, examine, lubricate, test, and re-adjust doors as required for proper operation.

### 3.2.2 CLEANING

Clean aluminum doors in accordance with manufacturer's approved instructions.

## 3.3 OPERATION AND MAINTENANCE

Submit 4 copies of the Operation and Maintenance Manuals 30 calendar days prior to testing the Overhead Coiling Door Assemblies. Update and resubmit data for final approval no later than 30 calendar days prior to contract completion.

Provide operation and maintenance manuals which are consistent with manufacturer's standard brochures, schematics, printed instructions, general operating procedures, and safety precautions. Provide test data that is legible and of good quality.

-- End of Section 08 33 23 --

SECTION 08 53 00
PLASTIC WINDOWS

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA/WDMA/CSA 101/I.S.2/A440 (2011) Standard/Specification for Windows, Doors, and Skylights

ASTM INTERNATIONAL (ASTM)

ASTM D3656/D3656M (2013) Insect Screening and Louver Cloth Woven from Vinyl-Coated Glass Yarns

1.2 SUBMITTALS

Contracting Officer's written approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Windows

Indicate elevations of windows, full-size sections, thicknesses of PVC, reinforcing members, fastenings, proposed method of anchoring, size and spacing of anchors, details of construction, method of glazing, details of operating hardware, method and materials for weatherstripping, method of attaching screens, material and method of attaching subframes, stools, casings, sills, trim, accessories, installation details, window flashings and other related items.

Schedule of windows

Submit with drawings indicating location of each window unit.

SD-03 Product Data

Windows

Fasteners

Hardware

Screens

Weatherstripping

Accessories

SD-06 Test Reports

Windows

Submit for each window type attesting that identical or larger windows have been tested and meet the requirements specified herein for conformance to AAMA/WDMA/CSA 101/I.S.2/A440 and the specified minimum Condensation Resistance Factor (CRF).

SD-07 Certificates

Windows

Submit NFRC Certification documentation.

SD-10 Operation and Maintenance Data

Windows

Submit data package in accordance with Section 01 78 23 OPERATING INSTRUCTIONS AND TRAINGING.

## 1.3 QUALITY ASSURANCE

### 1.3.1 Labels

Each window unit shall bear a certification label from an independent, nationally recognized testing organization validating that the product complies with AAMA/WDMA/CSA 101/I.S.2/A440 for the type, grade, and performance class specified.

### 1.3.2 Certification

Certified test reports attesting that the window units meet the requirements of AAMA/WDMA/CSA 101/I.S.2/A440 as specified will be acceptable in lieu of product labeling or marking.

## 1.4 DELIVERY, STORAGE, AND HANDLING

Deliver windows to the project site in an undamaged condition. Use care in handling and hoisting windows during transportation and at the job site. Store windows and components out of contact with the ground, under a weathertight covering, to prevent bending, warping, or otherwise damaging the windows. Repair damaged windows to an "as new" condition as approved. Provide new units if windows cannot be repaired.

## 1.5 PROTECTION

Protect finished surfaces during shipping and handling using the manufacturer's standard method, except do not apply coatings or lacquers on surfaces to receive caulking and glazing compounds.

# PART 2 PRODUCTS

## 2.1 GENERAL REQUIREMENTS FOR WINDOWS

Windows shall conform to AAMA/WDMA/CSA 101/I.S.2/A440 and to requirements specified herein. Provide windows of materials, types, grades, performance classes, combinations and sizes indicated or specified. Each window shall be a unit consisting of frame, sash, glass, hardware, trim, casing, screen, weatherstripping, anchors and accessories complete. Design windows to accommodate glass, hardware, screens, weatherstripping, and accessories to be furnished. Glass shall be factory or field installed.

## 2.2 MATERIALS

### 2.2.1 Windows

Provide PVC, reinforcing members, fasteners, hardware, weatherstripping, and anchors conforming to AAMA/WDMA/CSA 101/I.S.2/A440 and as specified herein.

### 2.2.2 Glass and Glazing

As specified in Section 08 81 00 GLAZING.

### 2.2.3 Caulking and Sealing

As specified in Section 07 92 00 JOINT SEALANTS.

### 2.2.4 Insect Screening

ASTM D3656/D3656M, Class 2, 18 by 14 mesh, color grey.

### 2.2.5 Accessories

As standard with the manufacturer and as specified herein.

## 2.3 WINDOW TYPES

Windows shall be of the following types, as indicated.

### 2.3.1 Horizontal Sliding Windows

AAMA/WDMA/CSA 101/I.S.2/A440, Type CW-PG50.

## 2.4 FABRICATION

Conform to AAMA/WDMA/CSA 101/I.S.2/A440 and to the requirements specified herein.

### 2.4.1 Frames and Sash

#### 2.4.1.1 Corners and Reinforcement

Corners of PVC frames and sashes shall be mechanically fixed and sealed or welded. Reinforce frames and sash as necessary to meet the requirements for the performance classes or grades specified herein.

#### 2.4.1.2 Adjustability

Ventilating sash shall be adjustable vertically and horizontally to ensure smooth operation.

#### 2.4.1.3 Drips and Weep Holes

Provide continuous drips over heads of top ventilators. Where fixed windows adjoin ventilators, provide continuous drips across tops of fixed windows. Provide drips and weep holes as required to return water to the outside.

#### 2.4.1.4 Provisions for Glazing

Design windows and rabbets suitable for glass thickness shown. Design sash for inside double glazing and for securing glass with glazing beads.

### 2.4.2 Hardware

The item, type, and functional characteristics shall be the manufacturer's standard for the particular window type. Provide hardware of suitable design and of sufficient strength to perform the function for which it is used. Equip operating ventilators with a lock or latching device which can be secured from the inside.

### 2.4.3 Weatherstripping

Provide for ventilating sections of windows to ensure a weathertight seal meeting the infiltration requirements specified in AAMA/WDMA/CSA 101/I.S.2/A440. Provide easily replaceable factory-applied weatherstripping.

2.4.4 Screens

Provide one insect screen for each operable exterior sash or ventilator. Design screens to be rewirable, easily removable from inside the building, and to permit easy access to operating hardware.

2.4.5 Color

Window (PVC) color shall be white. Color shall be integral or co-extruded to the PVC to prevent heat build-up.

2.4.6 Fasteners

Provide fastener types as standard with the window manufacturer for windows, trim, and accessories.

2.4.7 Accessories

Provide windows complete with clips, fins, anchors, and other appurtenances necessary for complete installation and proper operation.

2.4.7.1 Anchors

Provide concealed anchors of the type recommended by the window manufacturer for the specific type of construction. Anchors and fasteners shall be compatible with the window and the adjoining construction. For each jamb 36 inches or longer, provide a minimum of three anchors located approximately 6 inches from each end and at midpoint. For jambs less than 36 inches long, provide two anchors.

PART 3 EXECUTION

3.1 INSTALLATION

Install in accordance with the window manufacturer's printed instructions and details. Build in windows as work progresses or install without forcing into prepared window openings. Set windows at proper elevation, location, and reveal; plumb, square, level, and in alignment; and brace, strut, and stay properly to prevent distortion and misalignment. Bed screws or bolts in sill members, joints at mullions, contacts of windows with sills, built-in fins, and subframes in mastic sealant of a type recommended by the window manufacturer. Install and seal windows in a manner that will prevent entrance of water and wind. Fasten insect screens securely in place. Fasten hardware to windows.

### 3.1.1 Anchors and Fastenings

Secure units to each other, to masonry, and to other adjoining construction with clips, fins, screws, or other devices recommended by the window manufacturer.

## 3.2 ADJUSTING

After installation of windows and completion of glazing and field painting, adjust ventilators and hardware to operate smoothly and to provide weathertight sealing when ventilators are closed and locked. Lubricate hardware and operating parts as necessary. Verify products are properly installed, connected, and adjusted.

## 3.3 CLEANING

Clean interior and exterior surfaces of window units of mortar, plaster, paint spattering spots, and other foreign matter to present a neat appearance, to prevent fouling of weathering surfaces and weatherstripping, and to prevent interference with operation of hardware. Replace stained, discolored, or abraded windows that cannot be restored to their original condition with new windows.

## 3.4 PROTECTION

Protect ventilators and operating parts against accumulation of dirt and building materials by keeping ventilators tightly closed and locked to frame.

-- End of Section 08 53 00 --

SECTION 08 71 00
DOOR HARDWARE

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM E283 | (2004; R 2012) Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen |

BUILDERS HARDWARE MANUFACTURERS ASSOCIATION (BHMA)

| | |
|---|---|
| ANSI/BHMA A156.1 | (2013) Butts and Hinges |
| ANSI/BHMA A156.13 | (2012) Mortise Locks & Latches Series 1000 |
| ANSI/BHMA A156.16 | (2013) Auxiliary Hardware |
| ANSI/BHMA A156.18 | (2012) Materials and Finishes |
| ANSI/BHMA A156.2 | (2011) Bored and Preassembled Locks and Latches |
| ANSI/BHMA A156.21 | (2009) Thresholds |
| ANSI/BHMA A156.3 | (2014) Exit Devices |
| ANSI/BHMA A156.4 | (2013) Door Controls - Closers |
| ANSI/BHMA A156.7 | (2003; R 2009) Template Hinge Dimensions |
| ANSI/BHMA A156.8 | (2010) Door Controls - Overhead Stops and Holders |
| BHMA A156.22 | (2012) Door Gasketing and Edge Seal Systems |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 101 | (2012; Amendment 1 2012) Life Safety Code |

STEEL DOOR INSTITUTE (SDI/DOOR)

SDI/DOOR A250.8 (2003; R2008) Recommended Specifications for Standard Steel Doors and Frames

UNDERWRITERS LABORATORIES (UL)

UL Bld Mat Dir (2012) Building Materials Directory

## 1.2 SUBMITTALS

Contracting Officer's written approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Hardware schedule

Keying system

SD-03 Product Data

Hardware items

SD-08 Manufacturer's Instructions

Installation

SD-10 Operation and Maintenance Data

Hardware Schedule items

Submit data package in accordance with Section 01 78 23 OPERATING INSTRUCTIONS AND TRAINGING.

SD-11 Closeout Submittals

Key Bitting

## 1.3 HARDWARE SCHEDULE

Prepare and submit hardware schedule in the following form:

| Hardware Item | Quantity | Size | Reference Publi-cation Type No. | Finish | Mfr Name and Catalog No. | Key Control Symbols | UL Mark (If fire rated and listed) | BHMA Finish Desig-nation |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |

1.4 KEY BITTING CHART REQUIREMENTS

Submit key bitting charts to the Contracting Officer prior to completion of the work. Include:

a. Complete listing of all keys (AA1, AA2, etc.).

b. Complete listing of all key cuts (AA1-123456, AA2-123458).

c. Tabulation showing which key fits which door.

d. Copy of floor plan showing doors and door numbers.

e. Listing of 20 percent more key cuts than are presently required in each master system.

1.5 QUALITY ASSURANCE

1.5.1 Hardware Manufacturers and Modifications

Provide, as far as feasible, locks, hinges, and closers of one lock, hinge, or closer manufacturer's make. Modify hardware as necessary to provide features indicated or specified.

1.5.2 Key Shop Drawings Coordination Meeting

Prior to the submission of the key shop drawing, the Contracting Officer’s Representative, Contractor, Door Hardware subcontractor, using Activity and Base Locksmith shall meet to discuss key requirements for the facility.

1.6 DELIVERY, STORAGE, AND HANDLING

Deliver hardware in original individual containers, complete with necessary appurtenances including fasteners and instructions. Mark each individual container with item number as shown in hardware schedule. Deliver permanent keys to the Contracting Officer’s Representative, either directly or by certified mail. Deliver construction master keys with the locks.

PART 2 PRODUCTS

2.1 TEMPLATE HARDWARE

Provide hardware to be applied to metal manufactured to template. Promptly furnish template information or templates to door and frame manufacturers. Conform to ANSI/BHMA A156.7 for template hinges. Coordinate hardware items to prevent interference with other hardware.

## 2.2 HARDWARE FOR EXIT DOORS

Provide all hardware necessary to meet the requirements of NFPA 101 for exit doors, as well as to other requirements indicated, even if such hardware is not specifically mentioned under paragraph entitled "Hardware Schedule." Provide the label of Underwriters Laboratories, Inc. for such hardware listed in UL Bld Mat Dir or labeled and listed by another testing laboratory acceptable to the Contracting Officer.

## 2.3 HARDWARE ITEMS

Clearly and permanently mark with the manufacturer's name or trademark, hinges, pivots, locks, latches, exit devices, bolts and closers where the identifying mark will be visible after the item is installed. For closers with covers, the name or trademark may be beneath the cover.

### 2.3.1 Hinges

ANSI/BHMA A156.1, 4-1/2 by 4-1/2 inch unless otherwise indicated. Construct loose pin hinges for exterior doors and reverse-bevel interior doors so that pins will be nonremovable when door is closed. Other antifriction bearing hinges may be provided in lieu of ball-bearing hinges.

### 2.3.2 Locks and Latches

#### 2.3.2.1 Mortise Locks and Latches

ANSI/BHMA A156.13, Series 1000, Operational Grade 1, Security Grade 2. Install knobs and roses of mortise locks with screwless shanks and no exposed screws.

#### 2.3.2.2 Bored Locks and Latches

ANSI/BHMA A156.2, Series 4000, Grade 1.

### 2.3.3 Exit Devices

ANSI/BHMA A156.3, Grade 1. Provide adjustable strikes for rim type and vertical rod devices. Provide open back strikes for pairs of doors with mortise and vertical rod devices. Provide touch bars in lieu of conventional crossbars and arms.

### 2.3.4 Cylinders and Cores

Provide cylinders for new locks, including locks provided under other sections of this specification. Provide fully compatible cylinders with products of the Best Lock Corporation

with interchangeable cores which are removable by a special control key. Factory set the cores with seven pin tumblers using the A4 system and F keyway. Submit a core code sheet with the cores. Provide master keyed cores in one system for this project. Provide construction interchangeable cores.

2.3.5 Keying System

Provide a master keying system that is an extension of the existing keying system at the facility. Existing locks were manufactured by Best and have interchangeable cores.

2.3.6 Lock Trim

Cast, forged, or heavy wrought construction and commercial plain design.

2.3.6.1 Knobs and Roses

Conform to the minimum test requirements of ANSI/BHMA A156.2 and ANSI/BHMA A156.13 for knobs, roses, and escutcheons. For unreinforced knobs, roses, and escutcheons, provide 0.050 inch thickness. For reinforced knobs, roses, and escutcheons, provide outer shell of 0.035 inch thickness, and combined thickness of 0.070 inch, except for knob shanks, which are 0.060 inch thick.

2.3.6.2 Lever Handles

Provide lever handles in lieu of knobs. Conform to the minimum requirements of ANSI/BHMA A156.13 for mortise locks of lever handles for exit devices. Provide lever handle locks with a breakaway feature (such as a weakened spindle or a shear key) to prevent irreparable damage to the lock when force in excess of that specified in ANSI/BHMA A156.13 is applied to the lever handle. Provide lever handles return to within 1/2 inch of the door face.

2.3.7 Keys

Furnish one file key, one duplicate key, and one working key for each key change and for each master keying system. Furnish one additional working key for each lock of each keyed-alike group. Furnish a quantity of key blanks equal to 20 percent of the total number of file keys. Stamp each key with appropriate key control symbol and "U.S. property - Do not duplicate." Do not place room number on keys.

2.3.8 Closers

ANSI/BHMA A156.4, Series C02000, Grade 1, with PT 4C. Provide with brackets, arms, mounting devices, fasteners, and other features necessary for the particular application. Size closers in accordance with manufacturer's recommendations, or provide multi-size closers, Sizes 1 through 6, and list sizes in the Hardware Schedule. Provide manufacturer's standard 10 year warranty.

2.3.8.1 Identification Marking

Engrave each closer with manufacturer's name or trademark, date of manufacture, and manufacturer's size designation located to be visible after installation.

2.3.9 Overhead Holders

ANSI/BHMA A156.8.

2.3.10 Door Protection Plates

2.3.10.1 Sizes of Kick Plates

2 inch less than door width for single doors; one inch less than door width for pairs of doors. Provide 10 inch kick plates for flush doors.

2.3.11 Door Stops and Silencers

ANSI/BHMA A156.16. Silencers Type L03011. Provide three silencers for each single door, two for each pair.

2.3.12 Thresholds

ANSI/BHMA A156.21. Use J35100, with vinyl or silicone rubber insert in face of stop, for exterior doors opening out, unless specified otherwise.

2.3.13 Weather Stripping Gasketing

BHMA A156.22. Provide the type and function designation where specified in paragraph entitled "Hardware Schedule". Provide a set to include head and jamb seals. Air leakage of weather stripped doors not to exceed 1.25 cubic feet per minute of air per square foot of door area when tested in accordance with ASTM E283. Provide weather stripping with one of the following:

2.3.13.1 Extruded Aluminum Retainers

Extruded aluminum retainers not less than 0.050 inch wall thickness with vinyl, neoprene, silicone rubber, or polyurethane inserts. Provide clear (natural) anodized aluminum.

2.3.13.2 Interlocking Type

Zinc or bronze not less than 0.018 inch thick.

2.3.13.3 Spring Tension Type

Spring bronze or stainless steel not less than 0.008 inch thick.

2.3.14 Rain Drips

Extruded aluminum, not less than 0.08 inch thick, clear anodized. Set drips in sealant and fasten with stainless steel screws.

2.3.14.1 Door Rain Drips

Approximately 1-1/2 inch high by 5/8 inch projection. Align bottom with bottom edge of door.

2.3.14.2 Overhead Rain Drips

Approximately 1-1/2 inch high by 2-1/2 inch projection, with length equal to overall width of door frame. Align bottom with door frame rabbet.

2.3.15 Special Tools

Provide special tools, such as spanner and socket wrenches and dogging keys, required to service and adjust hardware items.

2.4 FASTENERS

Provide fasteners of proper type, quality, size, quantity, and finish with hardware. Provide stainless steel or nonferrous metal fasteners that are exposed to weather. Provide fasteners of type necessary to accomplish a permanent installation.

2.5 FINISHES

ANSI/BHMA A156.18. Provide hardware in BHMA 630 finish (satin stainless steel), unless specified otherwise. Provide items not manufactured in stainless steel in BHMA 626 finish (satin chromium plated) over brass or bronze, except aluminum paint finish for surface door closers, and except BHMA 652 finish (satin chromium plated) for steel hinges. Provide hinges for exterior doors in stainless steel with BHMA 630 finish or chromium plated brass or bronze with BHMA 626 finish. Furnish exit devices in BHMA 626 finish in lieu of BHMA 630 finish. Match exposed parts of concealed closers to lock and door trim.

PART 3 EXECUTION

3.1 INSTALLATION

Install hardware in accordance with manufacturers' printed installation instructions. Fasten hardware to wood surfaces with full-threaded wood screws or sheet metal screws. Provide machine screws set in expansion shields for fastening hardware to solid concrete and masonry surfaces. Provide toggle bolts where required for fastening to hollow core construction. Provide through bolts where necessary for satisfactory installation.

3.1.1 Weather Stripping Installation

Handle and install weather stripping to prevent damage. Provide full contact, weather-tight seals. Operate doors without binding.

3.1.1.1 Stop-Applied Weather Stripping

Fasten in place with color-matched sheet metal screws not more than 9 inch on center after doors and frames have been finish painted.

3.1.1.2 Interlocking Type Weather Stripping

Provide interlocking, self-adjusting type on heads and jambs and flexible hook type at sills. Nail weather stripping to door 1 inch on center and to heads and jambs at 4 inch on center

3.1.1.3 Spring Tension Type Weather Stripping

Provide spring tension type on heads and jambs. Provide bronze nails with bronze, stainless steel nails with stainless steel. Space nails not more than 1-1/2 inch on center.

3.1.2 Threshold Installation

Extend thresholds the full width of the opening and notch end for jamb stops. Set thresholds in a full bed of sealant and anchor to floor with cadmium-plated, countersunk, steel screws in expansion sleeves.

3.2 EXIT DOORS

Install hardware in accordance with NFPA 101 for exit doors.

3.3 HARDWARE LOCATIONS

SDI/DOOR A250.8, unless indicated or specified otherwise.

a. Kick Plates: Push side of single-acting doors. Both sides of double-acting doors.

3.4 FIELD QUALITY CONTROL

After installation, protect hardware from paint, stains, blemishes, and other damage until acceptance of work. Submit notice of testing 15 days before scheduled, so that testing can be witnessed by the Contracting Officer’s Representative. Adjust hinges, locks, latches, bolts, holders, closers, and other items to operate properly. Demonstrate that permanent keys operate respective locks, and give keys to the Contracting Officer’s Representative. Correct, repair, and finish, as directed, errors in cutting and fitting and damage to adjoining work.

## 3.5 HARDWARE SETS

Deliver Hardware templates and hardware, except field-applied hardware to the door and frame manufacturer for use in fabricating the doors and frames.

Hardware schedule below is for establishing operation and function of door. Contractor shall provide separate complete hardware schedule for all doors.

**HW-1 (Exterior Exit Doors)**

| | | |
|---|---|---|
| 3 EACH HINGES | BHMA | A211 NRP 4.5 INCHES X 4.5 INCHES 630 |
| 1 EACH EXIT DEVICE | BHMA | TYPE 1 FO3 630 |
| 1 EACH CYLINDER | BHMA | E19211 I.C. 626 |
| 1 EACH CLOSER/STOP | BHMA | C2021 PT, C, D, G & H 689XTBGN |
| 1 EACH KICK PLATE | BHMA | J102 10 INCHES LDW 630 |
| 1 EACH THRESHOLD | BHMA | J35100 X LGT REQD |
| 1 SET WEATHERSTRIPPING/ RAIN DRIPS | BHMA | AS SPECIFIED |
| 2 EACH SILENCERS | BHMA | L03011 |

**HW-2 (Head)**

| | | |
|---|---|---|
| 3 EACH HINGES | BHMA | A2112 4.5 INCHES X 4.5 INCHES 630 |
| 1 EACH PRIVACY SET | BHMA | 4000 GRI F76 626 |
| 1 EACH CLOSER | BHMA | C02011 PT4C 689XTBGN |
| 1 EACH KICK PLATE | BHMA | J102 10 INCHES LDW 630 |
| 1 EACH FLOOR STOP | BHMA | L02041 626 |
| 3 EACH SILENCERS | BHMA | L03011 |

-- End of Section 08 71 00 --

SECTION 08 81 00
GLAZING

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

| | |
|---|---|
| ANSI Z97.1 | (2009; Errata 2010) Safety Glazing Materials Used in Buildings - Safety Performance Specifications and Methods of Test |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM C1036 | (2010; E 2012) Standard Specification for Flat Glass |
| ASTM C1172 | (2009; E 2011) Standard Specification for Laminated Architectural Flat Glass |
| ASTM C509 | (2006; R 2011) Elastomeric Cellular Preformed Gasket and Sealing Material |
| ASTM C864 | (2005; R 2011) Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers |
| ASTM C920 | (2014a) Standard Specification for Elastomeric Joint Sealants |
| ASTM D2287 | (2012) Nonrigid Vinyl Chloride Polymer and Copolymer Molding and Extrusion Compounds |
| ASTM D395 | (2014) Standard Test Methods for Rubber Property - Compression Set |
| ASTM E1300 | (2012a; E 2012) Determining Load Resistance of Glass in Buildings |

GLASS ASSOCIATION OF NORTH AMERICA (GANA)

| | |
|---|---|
| GANA Glazing Manual | (2004) Glazing Manual |
| GANA Sealant Manual | (2008) Sealant Manual |

INSULATING GLASS MANUFACTURERS ALLIANCE (IGMA)

| | |
|---|---|
| IGMA TB-3001 | (2001) Guidelines for Sloped Glazing |
| IGMA TM-3000 | (1990; R 2004) North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial & Residential Use |
| IGMA TR-1200 | (1983; R 2007) Guidelines for Commercial Insulating Glass Dimensional Tolerances |

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

| | |
|---|---|
| Energy Star | (1992; R 2006) Energy Star Energy Efficiency Labeling System (FEMP) |

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

| | |
|---|---|
| 16 CFR 1201 | Safety Standard for Architectural Glazing Materials |

1.2 SUBMITTALS

Contracting Officer's written approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Insulating Glass Units

Documentation for Energy Star qualifications.

Glazing Accessories

Manufacturer's descriptive product data, handling and storage recommendations, installation instructions, and cleaning instructions.

SD-07 Certificates

Insulating Glass Warranty

Certificates stating that the glass meets the specified requirements. Labels or manufacturers marking affixed to the glass will be accepted in lieu of certificates.

Glazing Accessories

SD-08 Manufacturer's Instructions

Setting and sealing materials

Glass setting

Submit glass manufacturer's recommendations for setting and sealing materials and for installation of each type of glazing material specified.

## 1.3 SYSTEM DESCRIPTION

Glazing systems shall be fabricated and installed watertight and airtight to withstand thermal movement and wind loading without glass breakage, gasket failure, deterioration of glazing accessories, and defects in the work. Glazed panels shall comply with the safety standards, as indicated in accordance with ANSI Z97.1. Glazed panels shall comply with indicated wind/snow loading in accordance with ASTM E1300.

## 1.4 DELIVERY, STORAGE, AND HANDLING

Deliver products to the site in unopened containers, labeled plainly with manufacturers' names and brands. Store glass and setting materials in safe, enclosed dry locations and do not unpack until needed for installation. Handle and install materials in a manner that will protect them from damage.

## 1.5 ENVIRONMENTAL REQUIREMENTS

Do not start glazing work until the outdoor temperature is above 40 degrees F and rising, unless procedures recommended by the glass manufacturer and approved by the Contracting Officer are made to warm the glass and rabbet surfaces. Provide ventilation to prevent condensation of moisture on glazing work during installation. Do not perform glazing work during damp or rainy weather.

## 1.6 STANDARD WARRANTY

### 1.6.1 Standard Warranty for Insulating Glass Units

Warranty insulating glass units against development of material obstruction to vision (such as dust, fogging, or film formation on the inner glass surfaces) caused by failure of the hermetic seal, other than through glass breakage, for a 10-year period following acceptance of the work. Provide new units for any units failing to comply with terms of this warranty within 45 working days after receipt of notice from the Government.

# PART 2 PRODUCTS

## 2.1 GLASS

ASTM C1036, unless specified otherwise. In doors and sidelights, provide safety glazing material conforming to 16 CFR 1201.

### 2.1.1 Laminated Glass

ASTM C1172, Kind LA fabricated from two nominal 1/8 inchpieces of Type I, Class 1, Quality q3, flat annealed transparent glass conforming to ASTM C1036. Flat glass shall be laminated together with a minimum of 0.030 inchthick, clear polyvinyl butyral interlayer. The total thickness shall be nominally 1/4 inch.

## 2.2 INSULATING GLASS UNITS

Two panes of glass separated by a dehydrated airspace and hermetically sealed. Dimensional tolerances shall be as specified in IGMA TR-1200. Spacer shall be roll-formed, with bent or tightly welded or keyed and sealed joints to completely seal the spacer periphery and eliminate moisture and hydrocarbon vapor transmission into airspace through the corners. Primary seal shall be compressed polyisobutylene and the secondary seal shall be a specially formulated silicone.

### 2.2.1 Low Emissivity Insulating Glass

Interior and exterior glass panes for Low-E insulating units shall be Type I annealed flat glass, Class 2-tinted with anti-reflective low-emissivity coating on No. 2 surface (inside surface of exterior pane), Quality q3 - glazing select, conforming to ASTM C1036. Glass performance shall be U value maximum of 0.28 Btu/hr-ft2-F. Color shall be gray.

## 2.3 SETTING AND SEALING MATERIALS

Provide as specified in the GANA Glazing Manual, IGMA TM-3000, IGMA TB-3001, and manufacturer's recommendations, unless specified otherwise herein. Do not use metal sash putty, nonskinning compounds, nonresilient preformed sealers, or impregnated preformed gaskets. Materials exposed to view and unpainted shall be gray or neutral color.

### 2.3.1 Putty and Glazing Compound

Glazing compound shall be as recommended by manufacturer for face-glazing metal sash. Putty shall be linseed oil type. Putty and glazing compounds shall not be used with insulating glass or laminated glass.

### 2.3.2 Glazing Compound

Use for face glazing metal sash. Do not use with insulating glass units or laminated glass.

### 2.3.3 Sealants

Provide elastomeric sealants.

2.3.3.1 Elastomeric Sealant

ASTM C920, Type S, Grade NS, Class 12.5, Use G. Use for channel or stop glazing metal sash. Sealant shall be chemically compatible with setting blocks, edge blocks, and sealing tapes, with sealants used in manufacture of insulating glass units. Color of sealant shall be white.

2.3.4 Joint Backer

Joint backer shall have a diameter size at least 25 percent larger than joint width; type and material as recommended in writing by glass and sealant manufacturer.

2.3.5 Preformed Channels

Neoprene, vinyl, or rubber, as recommended by the glass manufacturer for the particular condition.

2.3.6 Sealing Tapes

Preformed, semisolid, PVC-based material of proper size and compressibility for the particular condition, complying with ASTM D2287. Use only where glazing rabbet is designed for tape and tape is recommended by the glass or sealant manufacturer. Provide spacer shims for use with compressible tapes. Tapes shall be chemically compatible with the product being set.

2.3.7 Setting Blocks and Edge Blocks

Closed-cell neoprene setting blocks shall be dense extruded type conforming to ASTM C509 and ASTM D395, Method B, Shore A durometer between 70 and 90. Edge blocking shall be Shore A durometer of 50 (plus or minus 5). Silicone setting blocks shall be required when blocks are in contact with silicone sealant. Profiles, lengths and locations shall be as required and recommended in writing by glass manufacturer. Block color shall be black.

2.3.8 Glazing Gaskets

Glazing gaskets shall be extruded with continuous integral locking projection designed to engage into metal glass holding members to provide a watertight seal during dynamic loading, building movements and thermal movements. Glazing gaskets for a single glazed opening shall be continuous one-piece units with factory-fabricated injection-molded corners free of flashing and burrs. Glazing gaskets shall be in lengths or units recommended by manufacturer to ensure against pull-back at corners. Glazing gasket profiles shall be as recommended by the manufacturer for the intended application.

2.3.8.1 Fixed Glazing Gaskets

Fixed glazing gaskets shall be closed-cell (sponge) smooth extruded compression gaskets of cured elastomeric virgin neoprene compounds conforming to ASTM C509, Type 2, Option 1.

2.3.8.2 Wedge Glazing Gaskets

Wedge glazing gaskets shall be high-quality extrusions of cured elastomeric virgin neoprene compounds, ozone resistant, conforming to ASTM C864, Option 1, Shore A durometer between 65 and 75.

2.3.8.3 Aluminum Framing Glazing Gaskets

Glazing gaskets for aluminum framing shall be permanent, elastic, non-shrinking, non-migrating, watertight and weathertight.

2.3.9 Accessories

Provide as required for a complete installation, including glazing points, clips, shims, angles, beads, and spacer strips. Provide noncorroding metal accessories. Provide primer-sealers and cleaners as recommended by the glass and sealant manufacturers.

PART 3 EXECUTION

3.1 PREPARATION

Preparation, unless otherwise specified or approved, shall conform to applicable recommendations in the GANA Glazing Manual, GANA Sealant Manual, IGMA TB-3001, IGMA TM-3000, and manufacturer's recommendations. Determine the sizes to provide the required edge clearances by measuring the actual opening to receive the glass. Grind smooth in the shop glass edges that will be exposed in finish work. Leave labels in place until the installation is approved, except remove applied labels on heat-absorbing glass and on insulating glass units as soon as glass is installed. Securely fix movable items or keep in a closed and locked position until glazing compound has thoroughly set.

3.2 GLASS SETTING

Shop glaze or field glaze items to be glazed using glass of the quality and thickness specified or indicated. Glazing, unless otherwise specified or approved, shall conform to applicable recommendations in the GANA Glazing Manual, GANA Sealant Manual, IGMA TB-3001, IGMA TM-3000, and manufacturer's recommendations. Aluminum windows, wood doors, and wood windows may be glazed in conformance with one of the glazing methods described in the standards under which they are produced, except that face puttying with no bedding will not be permitted. Handle and install glazing materials in accordance with manufacturer's instructions. Use beads or stops which are furnished with items to be glazed to secure the glass in place. Verify products are properly installed, connected, and adjusted.

3.2.1 Insulating Glass Units

Do not grind, nip, or cut edges or corners of units after the units have left the factory. Springing, forcing, or twisting of units during setting will not be permitted. Handle units so as not to strike frames or other objects. Installation shall conform to applicable recommendations of IGMA TB-3001 and IGMA TM-3000.

3.2.2 Installation of Laminated Glass

Sashes which are to receive laminated glass shall be weeped to the outside to allow water drainage into the channel.

3.3 CLEANING

Clean glass surfaces and remove labels, paint spots, putty, and other defacement as required to prevent staining. Glass shall be clean at the time the work is accepted.

3.4 PROTECTION

Glass work shall be protected immediately after installation. Glazed openings shall be identified with suitable warning tapes, cloth or paper flags, attached with non-staining adhesives. Reflective glass shall be protected with a protective material to eliminate any contamination of the reflective coating. Protective material shall be placed far enough away from the coated glass to allow air to circulate to reduce heat buildup and moisture accumulation on the glass. Glass units which are broken, chipped, cracked, abraded, or otherwise damaged during construction activities shall be removed and replaced with new units.

-- End of Section 08 81 00 --

SECTION 09 22 00
SUPPORTS FOR GYPSUM BOARD

## PART 1 GENERAL

### 1.1 REFERENCES

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

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A463/A463M | (2010) Standard Specification for Steel Sheet, Aluminum-Coated, by the Hot-Dip Process |
| ASTM A653/A653M | (2013) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process |
| ASTM C645 | (2013) Nonstructural Steel Framing Members |
| ASTM C754 | (2011) Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products |
| ASTM C841 | (2003; R 2013) Installation of Interior Lathing and Furring |

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

| | |
|---|---|
| NAAMM EMLA 920 | (2009) Guide Specifications for Metal Lathing and Furring |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL Fire Resistance | (2012) Fire Resistance Directory |

### 1.2 DELIVERY, STORAGE, AND HANDLING

Deliver materials to the job site and store in ventilated dry locations. Storage area shall permit easy access for inspection and handling. If materials are stored outdoors, stack materials off the ground, supported on a level platform, and fully protected from the weather. Handle materials carefully to prevent damage. Remove damaged items and provide new items.

## PART 2 PRODUCTS

### 2.1 MATERIALS

Provide steel materials for metal support systems with galvanized coating ASTM A653/A653M, G-60; aluminum coating ASTM A463/A463M, T1-25; or a 55-percent aluminum-zinc coating.

2.1.1 Materials for Attachment of Gypsum Wallboard

2.1.1.1 Suspended and Furred Ceiling Systems

ASTM C645.

2.1.1.2 Nonload-Bearing Wall Framing and Furring

ASTM C645, but not thinner than 0.0179 inch thickness, with 0.0329 inch minimum thickness supporting wall hung items such as cabinetwork, equipment and fixtures.

2.1.1.3 Furring Structural Steel Columns

ASTM C645. Steel (furring) clips and support angles listed in UL Fire Resistance may be provided in lieu of steel studs for erection of gypsum wallboard around structural steel columns.

2.1.1.4 Z-Furring Channels with Wall Insulation

Not lighter than 26 gage galvanized steel, Z-shaped, with 1-1/4 inch and 3/4 inch flanges and 1 1/2 inch furring depth.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Systems for Attachment of Lath

3.1.1.1 Suspended and Furred Ceiling Systems and Wall Furring

ASTM C841, except as indicated otherwise.

3.1.1.2 Non-loadbearing Wall Framing

NAAMM EMLA 920, except provide framing members 16 inches o.c. unless indicated otherwise.

3.1.2 Systems for Attachment of Gypsum Wallboard

3.1.2.1 Suspended and Furred Ceiling Systems

ASTM C754, except provide framing members 16 inches o.c. unless indicated otherwise.

3.1.2.2 Non-loadbearing Wall Framing and Furring

ASTM C754, except as indicated otherwise.

3.2 ERECTION TOLERANCES

Provide framing members which will be covered by finish materials such as wallboard, or ceramic tile set in a mortar setting bed, within the following limits:

a. Layout of walls and partitions: 1/4 inch from intended position;

b. Plates and runners: 1/4 inch in 8 feet from a straight line;

c. Studs: 1/4 inch in 8 feet out of plumb, not cumulative; and

d. Face of framing members: 1/4 inch in 8 feet from a true plane.

-- End of Section 09 22 00 --

SECTION 09 29 00
GYPSUM BOARD

PART 1 GENERAL

1.1 REFERENCES

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

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM C1002 | (2007; R 2013) Standard Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs |
| ASTM C1047 | (2014a) Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base |
| ASTM C1396/C1396M | (2014) Standard Specification for Gypsum Board |
| ASTM C475/C475M | (2012) Joint Compound and Joint Tape for Finishing Gypsum Board |
| ASTM C840 | (2013) Application and Finishing of Gypsum Board |
| ASTM C954 | (2011) Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness |

GYPSUM ASSOCIATION (GA)

| | |
|---|---|
| GA 214 | (2010) Recommended Levels of Gypsum Board Finish |
| GA 216 | (2010) Application and Finishing of Gypsum Panel Products |

1.2 SUBMITTALS

Contracting Officer's written approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Gypsum Board

Joint Treatment Materials

SD-07 Certificates

Asbestos Free Materials

Certify that gypsum board types, gypsum backing board types, cementitious backer units, and joint treating materials do not contain asbestos.

SD-08 Manufacturer's Instructions

Material Safety Data Sheets

SD-10 Operation and Maintenance Data

Manufacturer maintenance instructions

## 1.3 DELIVERY, STORAGE, AND HANDLING

### 1.3.1 Delivery

Deliver materials in the original packages, containers, or bundles with each bearing the brand name, applicable standard designation, and name of manufacturer, or supplier.

### 1.3.2 Storage

Keep materials dry by storing inside a sheltered building. Where necessary to store gypsum board outside, store off the ground, properly supported on a level platform, and protected from direct exposure to rain, snow, sunlight, and other extreme weather conditions. Provide adequate ventilation to prevent condensation. Store per manufacturer's recommendations for allowable temperature and humidity range. Do not store panels near materials that may offgas or emit harmful fumes, such as kerosene heaters, fresh paint, or adhesives.

### 1.3.3 Handling

Neatly stack gypsum board units flat to prevent sagging or damage to the edges, ends, and surfaces.

## 1.4 ENVIRONMENTAL CONDITIONS

### 1.4.1 Temperature

Maintain a uniform temperature of not less than 50 degrees F in the structure for at least 48 hours prior to, during, and following the application of gypsum board, and joint treatment materials.

1.4.2 Exposure to Weather

Protect gypsum board and cementitious backer unit products from direct exposure to rain, snow, sunlight, and other extreme weather conditions.

PART 2 PRODUCTS

2.1 MATERIALS

Conform to specifications, standards and requirements specified. Provide gypsum board types, and joint treating materials manufactured from asbestos free materials only. Submit Material Safety Data Sheets and manufacturer maintenance instructions for gypsum materials including adhesives.

2.1.1 Gypsum Board

ASTM C1396/C1396M.

2.1.1.1 Regular

48 inch wide, 5/8 inch thick, tapered edges.

2.1.2 Joint Treatment Materials

ASTM C475/C475M. Use all purpose joint and texturing compound containing inert fillers and natural binders, including lime compound. Pre-mixed compounds shall be free of antifreeze, vinyl adhesives, preservatives, biocides and other slow releasing compounds.

2.1.2.1 Embedding Compound

Specifically formulated and manufactured for use in embedding tape at gypsum board joints and compatible with tape, substrate and fasteners.

2.1.2.2 Finishing or Topping Compound

Specifically formulated and manufactured for use as a finishing compound.

2.1.2.3 All-Purpose Compound

Specifically formulated and manufactured to serve as both a taping and a finishing compound and compatible with tape, substrate and fasteners.

2.1.2.4 Setting or Hardening Type Compound

Specifically formulated and manufactured for use with fiber glass mesh tape.

2.1.2.5 Joint Tape

Use cross-laminated, tapered edge, reinforced paper, or fiber glass mesh tape recommended by the manufacturer.

2.1.3 Fasteners

2.1.3.1 Screws

ASTM C1002, Type "G", Type "S" or Type "W" steel drill screws for fastening gypsum board to gypsum board, wood framing members and steel framing members less than 0.033 inch thick. ASTM C954 steel drill screws for fastening gypsum board to steel framing members 0.033 to 0.112 inch thick. Provide cementitious backer unit screws with a polymer coating.

2.1.4 Accessories

ASTM C1047. Fabricate from corrosion protected steel or plastic designed for intended use. Accessories manufactured with paper flanges are not acceptable. Flanges shall be free of dirt, grease, and other materials that may adversely affect bond of joint treatment. Provide prefinished or job decorated materials.

2.1.5 Water

Provide clean, fresh, and potable water.

PART 3 EXECUTION

3.1 EXAMINATION

3.1.1 Framing and Furring

Verify that framing and furring are securely attached and of sizes and spacing to provide a suitable substrate to receive gypsum board. Verify that all blocking, headers and supports are in place to support plumbing fixtures and to receive soap dishes, grab bars, towel racks, and similar items. Do not proceed with work until framing and furring are acceptable for application of gypsum board.

3.2 APPLICATION OF GYPSUM BOARD

Apply gypsum board to framing and furring members in accordance with ASTM C840 or GA 216 and the requirements specified.

3.2.1 Application of Gypsum Board to Steel Framing and Furring

Apply in accordance with ASTM C840, System VIII or GA 216.

### 3.2.2 Floating Interior Angles

Minimize framing by floating corners with single studs and drywall clips. Locate the attachment fasteners adjacent to ceiling and wall intersections in accordance with ASTM C840, System XII or GA 216, for single-ply applications of gypsum board to wood framing.

### 3.2.3 Control Joints

Install expansion and contraction joints in ceilings and walls in accordance with ASTM C840, System XIII or GA 216.

## 3.3 FINISHING OF GYPSUM BOARD

Tape and finish gypsum board in accordance with ASTM C840, GA 214 and GA 216.

### 3.3.1 Uniform Surface

Wherever gypsum board is to receive eggshell, semigloss or gloss paint finish, or where severe, up or down lighting conditions occur, finish gypsum wall surface in accordance to GA 214 Level 5. In accordance with GA 214 Level 5, apply a thin skim coat of joint compound to the entire gypsum board surface, after the two-coat joint and fastener treatment is complete and dry.

## 3.4 SEALING

Seal openings around pipes, fixtures, and other items projecting through gypsum board and cementitious backer units as specified in Section 07 92 00 JOINT SEALANTS. Apply material with exposed surface flush with gypsum board or cementitious backer units.

## 3.5 PATCHING

Patch surface defects in gypsum board to a smooth, uniform appearance, ready to receive finishes.

-- End of Section 09 29 00 --

SECTION 09 90 00
PAINTS AND COATINGS

PART 1 GENERAL

1.1 REFERENCES

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

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM D235 | (2002; R 2012) Mineral Spirits (Petroleum Spirits) (Hydrocarbon Dry Cleaning Solvent) |
| ASTM D4263 | (1983; R 2012) Indicating Moisture in Concrete by the Plastic Sheet Method |
| ASTM D4444 | (2013) Use and Calibration of Hand-Held Moisture Meters |
| ASTM D523 | (2014) Standard Test Method for Specular Gloss |
| ASTM D6386 | (2010) Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting |
| ASTM F1869 | (2011) Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride |

MASTER PAINTERS INSTITUTE (MPI)

| | |
|---|---|
| MPI 107 | (Oct 2009) Rust Inhibitive Primer (Water-Based) |
| MPI 11 | (Oct 2009) Exterior Latex, Semi-Gloss, MPI Gloss Level 5 |
| MPI 116 | (Oct 2009) Epoxy Block Filler |
| MPI 141 | (Oct 2009) Interior High Performance Latex MPI Gloss Level 5 |
| MPI 23 | (Oct 2009) Surface Tolerant Metal Primer |
| MPI 26 | (Oct 2009) Cementitious Galvanized Metal Primer |
| MPI 47 | (Oct 2009) Interior Alkyd, Semi-Gloss, MPI Gloss Level 5 |

| | |
|---|---|
| MPI 48 | (Oct 2009) Interior Alkyd, Gloss, MPI Gloss Level 6 |
| MPI 50 | (Oct 2009) Interior Latex Primer Sealer |
| MPI 77 | (Oct 2009) Epoxy Gloss |
| MPI 79 | (Oct 2009) Alkyd Anti-Corrosive Metal Primer |
| MPI 9 | (Oct 2009) Exterior Alkyd, Gloss, MPI Gloss Level 6 |
| MPI 95 | (Oct 2009) Quick Drying Primer for Aluminum |

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

| | |
|---|---|
| SSPC PA 1 | (2000; E 2004) Shop, Field, and Maintenance Painting of Steel |
| SSPC SP 1 | (1982; E 2004) Solvent Cleaning |
| SSPC SP 12/NACE No.5 | (2002) Surface Preparation and Cleaning of Metals by Waterjetting Prior to Recoating |
| SSPC SP 2 | (1982; E 2000; E 2004) Hand Tool Cleaning |
| SSPC SP 3 | (1982; E 2004) Power Tool Cleaning |
| SSPC VIS 3 | (2004) Guide and Reference Photographs for Steel Surfaces Prepared by Hand and Power Tool Cleaning |

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

| | |
|---|---|
| FED-STD-313 | (2014; Rev E) Material Safety Data, Transportation Data and Disposal Data for Hazardous Materials Furnished to Government Activities |

## 1.2 SUBMITTALS

Contracting Officer's written approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

The current MPI, "Approved Product List" which lists paint by brand, label, product name and product code as of the date of contract award, will be used to determine compliance with the submittal requirements of this specification. The Contractor may choose to use a subsequent MPI "Approved Product List", however, only one list may be used for the entire contract and each coating system is to be from a single manufacturer. All coats on a particular substrate must be from a single manufacturer. No variation from the MPI Approved Products List is acceptable.

Samples of specified materials may be taken and tested for compliance with specification requirements.

SD-03 Product Data

Coating

Manufacturer's Technical Data Sheets

SD-04 Samples

Color

Submit manufacturer's samples of paint colors. Cross reference color samples to color scheme as indicated.

SD-07 Certificates

Applicator's qualifications

SD-08 Manufacturer's Instructions

Mixing

Detailed mixing instructions, minimum and maximum application temperature and humidity, potlife, and curing and drying times between coats.

Manufacturer's Material Safety Data Sheets

Submit manufacturer's Material Safety Data Sheets for coatings, solvents, and other potentially hazardous materials, as defined in FED-STD-313.

## 1.3 APPLICATOR'S QUALIFICATIONS

### 1.3.1 Contractor Qualification

Submit evidence that key personnel have successfully performed surface preparation and application of coatings on a minimum of three similar projects within the past three years.

## 1.4 ENVIRONMENTAL CONDITIONS

Comply, at minimum, with manufacturer recommendations for space ventilation during and after installation.

## 1.5 COLOR SELECTION

Submit manufacturer's standard color chips for color selection.

## 1.6 LOCATION AND SURFACE TYPE TO BE PAINTED

### 1.6.1 Painting Included

Where a space or surface is indicated to be painted, include the following unless indicated otherwise.

a. Surfaces behind portable objects and surface mounted articles readily detachable by removal of fasteners, such as screws and bolts.

b. New factory finished surfaces that require identification or color coding and factory finished surfaces that are damaged during performance of the work.

#### 1.6.1.1 Exterior Painting

Includes new surfaces.

#### 1.6.1.2 Interior Painting

Includes new surfaces.

### 1.6.2 Painting Excluded

Do not paint the following unless indicated otherwise.

a. Surfaces concealed and made inaccessible by panelboards, fixed ductwork, machinery, and equipment fixed in place.

b. Surfaces in concealed spaces. Concealed spaces are defined as enclosed spaces above suspended ceilings, furred spaces, attic spaces, crawl spaces, elevator shafts and chases.

c. Steel to be embedded in concrete.

d. Copper, stainless steel, aluminum, brass, and lead except existing coated surfaces.

e. Hardware, fittings, and other factory finished items.

### 1.6.3 Mechanical and Electrical Painting

Includes field coating of interior and exterior new surfaces.

a. Where a space or surface is indicated to be painted, include the following items unless indicated otherwise.

(1) Exposed piping, conduit, and ductwork;

(2) Supports, hangers, air grilles, and registers;

(3) Miscellaneous metalwork and insulation coverings.

1.6.4 Exterior Painting of Site Work Items

Field coat the following items:

New Surfaces

a. Steel Pipe Bollards

1.6.5 Definitions and Abbreviations

1.6.5.1 Qualification Testing

Qualification testing is the performance of all test requirements listed in the product specification. This testing is accomplished by MPI to qualify each product for the MPI Approved Product List, and may also be accomplished by Contractor's third party testing lab if an alternative to Batch Quality Conformance Testing by MPI is desired.

1.6.5.2 Batch Quality Conformance Testing

Batch quality conformance testing determines that the product provided is the same as the product qualified to the appropriate product specification. This testing shall only be accomplished by MPI testing lab.

1.6.5.3 Coating

A film or thin layer applied to a base material called a substrate. A coating may be a metal, alloy, paint, or solid/liquid suspensions on various substrates (metals, plastics, wood, paper, leather, cloth, etc.). They may be applied by electrolysis, vapor deposition, vacuum, or mechanical means such as brushing, spraying, calendaring, and roller coating. A coating may be applied for aesthetic or protective purposes or both. The term "coating" as used herein includes emulsions, enamels, stains, varnishes, sealers, epoxies, and other coatings, whether used as primer, intermediate, or finish coat. The terms paint and coating are used interchangeably.

1.6.5.4 DFT or dft

Dry film thickness, the film thickness of the fully cured, dry paint or coating.

1.6.5.5 DSD

Degree of Surface Degradation, the MPI system of defining degree of surface degradation. Five (5) levels are generically defined under the Assessment sections in the MPI Maintenance Repainting Manual.

1.6.5.6 EPP

Environmentally Preferred Products, a standard for determining environmental preferability in support of Executive Order 13101.

1.6.5.7 EXT

MPI short term designation for an exterior coating system.

1.6.5.8 INT

MPI short term designation for an interior coating system.

1.6.5.9 micron / microns

The metric measurement for 0.001 mm or one/one-thousandth of a millimeter.

1.6.5.10 mil / mils

The English measurement for 0.001 in or one/one-thousandth of an inch, equal to 25.4 microns or 0.0254 mm.

1.6.5.11 mm

The metric measurement for millimeter, 0.001 meter or one/one-thousandth of a meter.

1.6.5.12 MPI Gloss Levels

MPI system of defining gloss. Seven (7) gloss levels (G1 to G7) are generically defined under the Evaluation sections of the MPI Manuals. Traditionally, Flat refers to G1/G2, Eggshell refers to G3, Semigloss refers to G5, and Gloss refers to G6.

Gloss levels are defined by MPI as follows:

| Gloss Level | Description | Units at 60 degrees | Units at 85 degrees |
|---|---|---|---|
| G1 | Matte or Flat | 0 to 5 | 10 max |
| G2 | Velvet | 0 to 10 | 10 to 35 |
| G3 | Eggshell | 10 to 25 | 10 to 35 |

| | | | |
|---|---|---|---|
| G4 | Satin | 20 to 35 | 35 min |
| G5 | Semi-Gloss | 35 to 70 | |
| G6 | Gloss | 70 to 85 | |
| G7 | High Gloss | | |

Gloss is tested in accordance with ASTM D523. Historically, the Government has used Flat (G1 / G2), Eggshell (G3), Semi-Gloss (G5), and Gloss (G6).

1.6.5.13 MPI System Number

The MPI coating system number in each Division found in either the MPI Architectural Painting Specification Manual or the Maintenance Repainting Manual and defined as an exterior (EXT/REX) or interior system (INT/RIN). The Division number follows the CSI Master Format.

1.6.5.14 Paint

See Coating definition.

1.6.5.15 REX

MPI short term designation for an exterior coating system used in repainting projects or over existing coating systems.

1.6.5.16 RIN

MPI short term designation for an interior coating system used in repainting projects or over existing coating systems.

PART 2 PRODUCTS

2.1 MATERIALS

Conform to the coating specifications and standards referenced in PART 3. Submit manufacturer's technical data sheets for specified coatings and solvents.

PART 3 EXECUTION

3.1 PROTECTION OF AREAS AND SPACES NOT TO BE PAINTED

Prior to surface preparation and coating applications, remove, mask, or otherwise protect, hardware, hardware accessories, machined surfaces, radiator covers, plates, lighting fixtures, public and private property, and other such items not to be coated that are in contact with surfaces to be coated. Following completion of painting, workmen skilled in the trades involved shall reinstall removed items. Restore surfaces contaminated by coating materials, to original condition and repair damaged items.

## 3.2 SURFACE PREPARATION

Remove dirt, splinters, loose particles, grease, oil, disintegrated coatings, and other foreign matter and substances deleterious to coating performance as specified for each substrate before application of paint or surface treatments. Oil and grease shall be removed prior to mechanical cleaning. Cleaning shall be programmed so that dust and other contaminants will not fall on wet, newly painted surfaces. Exposed ferrous metals such as nail heads on or in contact with surfaces to be painted with water-thinned paints, shall be spot-primed with a suitable corrosion-inhibitive primer capable of preventing flash rusting and compatible with the coating specified for the adjacent areas.

## 3.3 PREPARATION OF METAL SURFACES

### 3.3.1 Ferrous Surfaces

a. Ferrous Surfaces including Shop-coated Surfaces and Small Areas That Contain Rust, Mill Scale and Other Foreign Substances: Solvent clean or detergent wash in accordance with SSPC SP 1 to remove oil and grease. Where shop coat is missing or damaged, clean according to SSPC SP 3.

### 3.3.2 Final Ferrous Surface Condition:

For tool cleaned surfaces, the requirements are stated in SSPC SP 2 and SSPC SP 3. As a visual reference, cleaned surfaces shall be similar to photographs in SSPC VIS 3.

### 3.3.3 Galvanized Surfaces

a. Galvanized Surfaces With Only Dirt and Zinc Oxidation Products: Clean with solvent, steam, or non-alkaline detergent solution in accordance with SSPC SP 1. If the galvanized metal has been passivated or stabilized, the coating shall be completely removed by brush-off abrasive blast. New galvanized steel to be coated shall not be "passivated" or "stabilized" If the absence of hexavalent stain inhibitors is not documented, test as described in ASTM D6386, Appendix X2, and remove by one of the methods described therein.

b. Galvanized with Slight Coating Deterioration or with Little or No Rusting: Water jetting to SSPC SP 12/NACE No.5 WJ3 to remove loose coating from surfaces with less than 20 percent coating deterioration and no blistering, peeling, or cracking. Use inhibitor as recommended by the coating manufacturer to prevent rusting.

### 3.3.4 Non-Ferrous Metallic Surfaces

Aluminum and aluminum-alloy, lead, copper, and other nonferrous metal surfaces.

Surface Cleaning: Solvent clean in accordance with SSPC SP 1 and wash with mild non-alkaline detergent to remove dirt and water soluble contaminants.

3.3.5 Terne-Coated Metal Surfaces

Solvent clean surfaces with mineral spirits, ASTM D235. Wipe dry with clean, dry cloths.

3.4 PREPARATION OF CONCRETE AND CEMENTITIOUS SURFACE

3.4.1 Concrete and Masonry

a. Curing: Concrete, and masonry surfaces shall be allowed to cure at least 30 days before painting, except concrete slab on grade, which shall be allowed to cure 90 days before painting.

b. Surface Cleaning: Remove the following deleterious substances.

(1) Dirt, Chalking, Grease, and Oil: Wash new surfaces with a solution composed of 1/2 cup trisodium phosphate, 1/4 cuphousehold detergent, and 4 quarts of warm water. Then rinse thoroughly with fresh water. For large areas, water blasting may be used.

(2) Fungus and Mold: Wash surfaces with a solution composed of 1/2 cup trisodium phosphate, 1/4 cup household detergent, 1 quart 5 percent sodium hypochlorite solution and 3 quarts of warm water. Rinse thoroughly with fresh water.

c. Allowable Moisture Content: Latex coatings may be applied to damp surfaces, but not to surfaces with droplets of water. Do not apply epoxies to damp vertical surfaces as determined by ASTM D4263 or horizontal surfaces that exceed 3 lbs of moisture per 1000 square feet in 24 hours as determined by ASTM F1869. In all cases follow manufacturers recommendations. Allow surfaces to cure a minimum of 30 days before painting.

3.4.2 Gypsum Board

a. Surface Cleaning: Gypsum board shall be dry. Remove loose dirt and dust by brushing with a soft brush, rubbing with a dry cloth, or vacuum-cleaning prior to application of the first coat material. A damp cloth or sponge may be used if paint will be water-based.

b. Repair of Minor Defects: Prior to painting, repair joints, cracks, holes, surface irregularities, and other minor defects with patching plaster or spackling compound and sand smooth.

c. Allowable Moisture Content: Latex coatings may be applied to damp surfaces, but not surfaces with droplets of water. Do not apply epoxies to damp surfaces as determined by ASTM D4263. New plaster to be coated shall have a maximum moisture content of 8 percent, when measured in accordance with ASTM D4444, Method A, unless otherwise authorized. In addition to moisture content requirements, allow new plaster to age a minimum of 30 days before preparation for painting.

## 3.5 APPLICATION

### 3.5.1 Coating Application

Painting practices shall comply with applicable federal, state and local laws enacted to insure compliance with Federal Clean Air Standards. Apply coating materials in accordance with SSPC PA 1. SSPC PA 1 methods are applicable to all substrates, except as modified herein.

At the time of application, paint shall show no signs of deterioration. Uniform suspension of pigments shall be maintained during application.

Unless otherwise specified or recommended by the paint manufacturer, paint may be applied by brush, roller, or spray. Use trigger operated spray nozzles for water hoses. Rollers for applying paints and enamels shall be of a type designed for the coating to be applied and the surface to be coated. Wear protective clothing and respirators when applying oil-based paints or using spray equipment with any paints.

Paints, except water-thinned types, shall be applied only to surfaces that are completely free of moisture as determined by sight or touch.

Thoroughly work coating materials into joints, crevices, and open spaces. Special attention shall be given to insure that all edges, corners, crevices, welds, and rivets receive a film thickness equal to that of adjacent painted surfaces.

Each coat of paint shall be applied so dry film shall be of uniform thickness and free from runs, drops, ridges, waves, pinholes or other voids, laps, brush marks, and variations in color, texture, and finish. Hiding shall be complete.

Touch up damaged coatings before applying subsequent coats. Interior areas shall be broom clean and dust free before and during the application of coating material.

a. Drying Time: Allow time between coats, as recommended by the coating manufacturer, to permit thorough drying, but not to present topcoat adhesion problems. Provide each coat in specified condition to receive next coat.

b. Primers, and Intermediate Coats: Do not allow primers or intermediate coats to dry more than 30 days, or longer than recommended by manufacturer, before applying subsequent coats. Follow manufacturer's recommendations for surface preparation if primers or intermediate coats are allowed to dry longer than recommended by manufacturers of subsequent coatings. Each coat shall cover surface of preceding coat or surface completely, and there shall be a visually perceptible difference in shades of successive coats.

c. Finished Surfaces: Provide finished surfaces free from runs, drops, ridges, waves, laps, brush marks, and variations in colors.

3.5.2 Mixing and Thinning of Paints

Reduce paints to proper consistency by adding fresh paint, except when thinning is mandatory to suit surface, temperature, weather conditions, application methods, or for the type of paint being used. Obtain written permission from the Contracting Officer to use thinners. The written permission shall include quantities and types of thinners to use.

When thinning is allowed, paints shall be thinned immediately prior to application with not more than 1 pint of suitable thinner per gallon. The use of thinner shall not relieve the Contractor from obtaining complete hiding, full film thickness, or required gloss. Thinning shall not cause the paint to exceed limits on volatile organic compounds. Paints of different manufacturers shall not be mixed.

3.5.3 Coating Systems

a. Systems by Substrates: Apply coatings that conform to the respective specifications listed in the following Tables:

Table

Division 5. Exterior Metal, Ferrous and Non-Ferrous Paint Table

Division 4. Interior Concrete Masonry Units Paint Table
Division 5. Interior Metal, Ferrous and Non-Ferrous Paint Table
Division 9: Interior Gypsum Board, Surfaces Paint Table

b. Minimum Dry Film Thickness (DFT): Apply paints, primers, varnishes, enamels, undercoats, and other coatings to a minimum dry film thickness of 1.5 mil each coat unless specified otherwise in the Tables. Coating thickness where specified, refers to the minimum dry film thickness.

c. Coatings for Surfaces Not Specified Otherwise: Coat surfaces which have not been specified, the same as surfaces having similar conditions of exposure.

3.6 COATING SYSTEMS FOR METAL

Apply coatings of Tables in Division 5 for Exterior and Interior.

a. Apply specified ferrous metal primer on the same day that surface is cleaned, to surfaces that meet all specified surface preparation requirements at time of application.

b. Inaccessible Surfaces: Prior to erection, use one coat of specified primer on metal surfaces that will be inaccessible after erection.

c. Shop-primed Surfaces: Touch up exposed substrates and damaged coatings to protect from rusting prior to applying field primer.

d. Surface Previously Coated with Epoxy or Urethane: Apply MPI 101, 1.5 mils DFT immediately prior to application of epoxy or urethane coatings.

e. Pipes and Tubing: The semitransparent film applied to some pipes and tubing at the mill is not to be considered a shop coat, but shall be overcoated with the specified ferrous-metal primer prior to application of finish coats.

f. Exposed Nails, Screws, Fasteners, and Miscellaneous Ferrous Surfaces. On surfaces to be coated with water thinned coatings, spot prime exposed nails and other ferrous metal with latex primer MPI 107.

## 3.7 COATING SYSTEMS FOR CONCRETE AND CEMENTITIOUS SUBSTRATES

Apply coatings of Tables in Division 9 for Exterior and Interior.

## 3.8 INSPECTION AND ACCEPTANCE

In addition to meeting previously specified requirements, demonstrate mobility of moving components, including swinging and sliding doors, cabinets, and windows with operable sash, for inspection by the Contracting Officer's Representative. Perform this demonstration after appropriate curing and drying times of coatings have elapsed and prior to invoicing for final payment.

## 3.9 PAINT TABLES

All DFT's are minimum values.

### 3.9.1 EXTERIOR PAINT TABLES

DIVISION 5: EXTERIOR METAL, FERROUS AND NON-FERROUS PAINT TABLE

STEEL / FERROUS SURFACES

A. New Steel

1. Alkyd
New; MPI EXT 5.1Q-G6 (Gloss) / Existing; MPI REX 5.1D-G6

| Primer: | Intermediate: | Topcoat: |
|---|---|---|
| MPI 23 | MPI 9 | MPI 9 |

System DFT: 5.25 mils

EXTERIOR GALVANIZED SURFACES

B. New Galvanized surfaces:

1. Cementitious primer / Latex
MPI EXT 5.3A-G5 (Semigloss)

| Primer: | Intermediate: | Topcoat: |
|---|---|---|
| MPI 26 | MPI 11 | MPI 11 |

System DFT: 4.5 mils

EXTERIOR SURFACES, OTHER METALS (NON-FERROUS)

C. Aluminum, aluminum alloy and other miscellaneous non-ferrous metal items not otherwise specified except hot metal surfaces, roof surfaces, and new prefinished equipment. Match surrounding finish:

1. Alkyd
MPI EXT 5.4F-G6 (Gloss)

| Primer: | Intermediate: | Topcoat: |
|---|---|---|
| MPI 95 | MPI 9 | MPI 9 |

System DFT: 5 mils

3.9.2 INTERIOR PAINT TABLES

DIVISION 4: INTERIOR CONCRETE MASONRY UNITS PAINT TABLE

A. New Concrete masonry units:

1. Epoxy
MPI INT 4.2G-G6 (Gloss)

| Filler: | Primer: | Intermediate: | Topcoat: |
|---|---|---|---|
| MPI 116 | N/A | MPI 77 | MPI 77 |

System DFT: 10 mils

Fill all holes in masonry surface

DIVISION 5: INTERIOR METAL, FERROUS AND NON-FERROUS PAINT TABLE

INTERIOR STEEL / FERROUS SURFACES

A. Metal:

1. High Performance Architectural Latex
MPI INT 5.1R-G5 (Semigloss)

| Primer: | Intermediate: | Topcoat: |
|---|---|---|
| MPI 79 | MPI 141 | MPI 141 |

System DFT: 5 mils

B. Metal in toilets:

1. Alkyd
MPI INT 5.1E-G6 (Gloss)
Primer: Intermediate: Topcoat:
MPI 79 MPI 48 MPI 48
System DFT: 5.25 mils

DIVISION 9: INTERIOR PLASTER, GYPSUM BOARD, TEXTURED SURFACES PAINT TABLE

A. Wallboard in toilets:

1. Alkyd
New; MPI INT 9.2C-G5 (Semigloss) / Existing; MPI RIN 9.2C-G5 (Semigloss)
Primer: Intermediate: Topcoat:
MPI 50 MPI 47 MPI 47
System DFT: 4 mils

-- End of Section 09 90 00 --

SECTION 10 28 13
TOILET ACCESSORIES

PART 1 GENERAL

1.1 REFERENCES

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

ASTM INTERNATIONAL (ASTM)

ASTM C1036 (2010; E 2012) Standard Specification for Flat Glass

1.2 SUBMITTALS

Contracting Officer's written approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Finishes
Accessory Items

SD-07 Certificates

Accessory Items

Warranty

1.3 DELIVERY, STORAGE, AND HANDLING

Wrap toilet accessories for shipment and storage, then deliver to the jobsite in manufacturer's original packaging, and store in a clean, dry area protected from construction damage and vandalism.

1.4 WARRANTY

Provide manufacturer's standard performance guarantees or warranties that extend beyond a 1 year period.

PART 2 PRODUCTS

2.1 MANUFACTURED UNITS

Provide toilet accessories where indicated in accordance with paragraph SCHEDULE. Provide each accessory item complete with the necessary mounting plates of sturdy construction with corrosion resistant surface.

2.1.1 Anchors and Fasteners

Provide anchors and fasteners capable of developing a restraining force commensurate with the strength of the accessory to be mounted and suited for use with the supporting construction. Provide tamperproof design exposed fasteners with finish to match the accessory.

2.1.2 Finishes

Except where noted otherwise, provide the following finishes on metal:

| Metal | Finish |
|---|---|
| Stainless steel | No. 4 satin finish |
| Carbon steel, copper alloy, and brass | Chromium plated, bright |

2.2 ACCESSORY ITEMS

Conform to the requirements for accessory items specified below.

2.2.1 Mirrors, Glass (MG)

Provide Type I transparent flat type, Class 1-clear glass for mirrors. Glazing Quality q1 1/4 inch thick conforming to ASTM C1036. Coat glass on one surface with silver coating, copper protective coating, and mirror backing paint.

2.2.2 Combination Paper Towel Dispenser/Waste Receptacle (PTDWR)

Provide recessed or semi-recessed dispenser/receptacle with a capacity of 400 sheets of C-fold, single-fold, or quarter-fold towel. Design waste receptacle to be locked in unit and removable for service. Provide tumbler key locking mechanism. Provide waste receptacle capacity of 12 gallons. Fabricate a minimum 0.03 inch stainless steel welded construction unit with all exposed surfaces having a satin finish. Provide waste receptacle that accepts reusable liner standard for unit manufacturer.

2.2.3 Shower Curtain (SC)

Provide shower curtain, size to suit conditions. Provide anti-bacterial nylon/vinyl fabric curtain. Color to be selected from manufacturers standard color section.

2.2.4 Shower Curtain Rods (SCR)

Provide Type 304 stainless steel shower curtain rods 1-1/4 inch OD by 0.049 inch minimum bent as required to meet installation conditions.

2.2.5 Soap Dispenser (SD)

Provide soap dispenser surface mounted, liquid type consisting of a vertical Type 304 stainless steel tank with holding capacity of 40 fluid ounces with a corrosion-resistant all-purpose valve that dispenses liquid soaps, lotions, detergents and antiseptic soaps.

2.2.6 Soap Holder (SH)

Provide surface mounted Type 304 stainless steel soap holder. Provide stainless steel separate supports.

2.2.7 Towel Pin (TP)

Provide towel pin with concealed wall fastenings, and a pin integral with or permanently fastened to wall flange with maximum projection of 4 inch. Provide bright polish finish.

2.2.8 Toilet Tissue Dispenser (TTD)

Furnish Type II - surface mounted toilet tissue holder with two rolls of standard tissue stacked vertically. Provide stainless steel, satin finish cabinet.

PART 3 EXECUTION

3.1 INSTALLATION

Provide the same finish for the surfaces of fastening devices exposed after installation as the attached accessory. Provide oval exposed screw heads. Install accessories at the location and height indicated. Protect exposed surfaces of accessories with strippable plastic or by other means until the installation is accepted. After acceptance of accessories, remove and dispose of strippable plastic protection. Coordinate accessory manufacturer's mounting details with other trades as their work progresses. Use sealants for brackets, plates, anchoring devices and similar items in showers (a silicone or polysulfide sealant) as they are set to provide a watertight installation. After installation, thoroughly clean exposed surfaces and restore damaged work to its original condition or replace with new work.

3.1.1 Recessed Accessories

Set anchors in mortar in masonry construction.

3.1.2 Surface Mounted Accessories

Mount on concealed backplates, unless specified otherwise. Conceal fasteners on accessories without backplates. Install accessories with sheet metal screws or wood screws in lead-lined

braided jute, PTFE or neoprene sleeves, or lead expansion shields, or with toggle bolts or other approved fasteners as required by the construction. Install backplates in the same manner, or provide with lugs or anchors set in mortar, as required by the construction. Fasten accessories mounted on gypsum board and plaster walls without solid backing into the metal or wood studs or to solid wood blocking secured between wood studs, or to metal backplates secured to metal studs.

## 3.2 CLEANING

Clean material in accordance with manufacturer's recommendations. Do not use alkaline or abrasive agents. Take precautions to avoid scratching or marring exposed surfaces.

-- End of Section 10 28 13 --

SECTION 10 44 16
FIRE EXTINGUISHERS

PART 1 GENERAL

1.1 REFERENCES

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

INTERNATIONAL CODE COUNCIL (ICC)

| | |
|---|---|
| ICC IFC | (2012) International Fire Code |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 1 | (2012; TIA 11-1) Fire Code |
| NFPA 10 | (2013) Standard for Portable Fire Extinguishers |
| NFPA 101 | (2012; Amendment 1 2012) Life Safety Code |

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

| | |
|---|---|
| 29 CFR 1910.157 | (2003) Portable Fire Extinguishers |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 299 | (2012) Dry Chemical Fire Extinguishers |

1.2 SUBMITTALS

Contracting Officer's written approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Fire Extinguishers

Accessories

Wall Brackets

Replacement Parts

SD-07 Certificates

Fire Extinguishers

Manufacturer's Warranty with Inspection Tag

## 1.3 DELIVERY, HANDLING, AND STORAGE

Protect materials from weather, soil, and damage during delivery, storage, and construction.

Deliver materials in their original packages, containers, or bundles bearing the brand name and the name and type of the material.

## 1.4 STANDARD WARRANTY

Guarantee that Fire Extinguishers are free of defects in materials, fabrication, finish, and installation and that they will remain so for a period of not less than 2 years after completion.

# PART 2 PRODUCTS

Submit fabrication drawings consisting of fabrication and assembly details performed in the factory and product data for the following items: Fire Extinguishers; Accessories, Wall Brackets.

## 2.1 TYPES

Provide Fire Extinguishers conforming to NFPA 10. Provide quantity and placement in compliance with the applicable sections of ICC IFC, Section 1414 and ICC IFC, Section 906, NFPA 1, NFPA 101, and 29 CFR 1910.157.

Provide dry chemical type fire extinguishers compliant with UL 299.

Submit Manufacturer's Data for each type of Fire Extinguisher required, detailing all related Cabinet, Wall Mounting and Accessories information, complete with Manufacturer's Warranty with Inspection Tag.

## 2.2 MATERIAL

Provide corrosion-resistant steel extinguisher shell.

## 2.3 SIZE

20 pounds extinguishers.

## 2.4 ACCESSORIES

Safety release

Pressure gage

## 2.5 WALL BRACKETS

Provide wall-hook fire extinguisher wall brackets.

Provide wall bracket and accessories as approved.

# PART 3 EXECUTION

## 3.1 INSTALLATION

Install Fire Extinguishers where indicated on the drawings. Verify exact locations prior to installation.

Comply with the manufacturer's recommendations for all installations.

Provide extinguishers which are fully charged and ready for operation upon installation. Provide extinguishers complete with Manufacturer's Warranty with Inspection Tag attached.

## 3.2 ACCEPTANCE PROVISIONS

### 3.2.1 Repairing

Remove and replace damaged and unacceptable portions of completed work with new work at no additional cost to the Government.

Submit Replacement Parts list indicating specified items replacement part, replacement cost, and name, address and contact for replacement parts distributor.

### 3.2.2 Cleaning

Clean all surfaces of the work, and adjacent surfaces which are soiled as a result of the work. Remove from the site all construction equipment, tools, surplus materials and rubbish resulting from the work.

-- End of Section 10 44 16 --

SECTION 13 12 10
FIBERGLASS REINFORCED PLASTIC ENCLOSURE

PART 1 GENERAL

1.1 REFERENCES

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

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM D638 | (2010) Standard Test Method for Tensile Properties of Plastics |
| ASTM D790 | (2010) Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials |
| ASTM E84 | (2014) Standard Test Method for Surface Burning Characteristics of Building Materials |

1.2 DESCRIPTION

Work included: Provide and install a factory-built above ground fiberglass reinforced plastic enclosure on a formed and poured concrete pad as specified herein.

1.3 SUBMITTALS

Contracting Officer's written approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fiberglass enclosure shop drawings showing plan, elevation and sectional views, materials of construction and anchor details.

SD-03 Product Data

Fiberglass enclosure Manufacturer's specifications and other data needed to prove compliance with the specified requirements.

SD-07 Certificates

Warranty

## 1.4 PRODUCT HANDLING

A. The fiberglass enclosure and the accessory items shall be carefully transported, stored, handled and set in place in a manner that will prevent distortion, misalignment or other damage to the units.

B. During storage prior to installation and following installation, but prior to placing in service, the manufacturer's recommendations regarding handling shall be followed.

## 1.5 STANDARD WARRANTY

The fiberglass enclosure shall be provided with a standard 5-year limited lifetime manufacturer's warranty against defects in material and workmanship.

# PART 2 PRODUCTS

## 2.1 FIBERGLASS ENCLOSURE

### 2.1.1 Enclosure Construction and Design

A. The fiberglass enclosure is to be provided with outside dimensions of 8' long by 4' wide and having an overall height not to exceed 10' at the exterior roof peak.

B. Provide a minimum of four (4) lifting eyes arranged on the corners to ease handling and installation onto a concrete pad furnished by the contractor.

C. Enclosure walls and roof shall be seamless, one-piece sprayed fiberglass panels laminated to form a structural composite as follows: 1/8" thick fiberglass outside surface, 1.5" thick foam polyisocyanurate core and 1/8" thick fiberglass inside surface. The core shall be rigid closed cell, self-extinguishing, polyisocyanurate Atlas Sheathing foam with a density of 2.0 pounds per cubic foot.

1. Laminate Properties:

    a. Tensile Strength (ASTM D638): 12,458 (psi)

    b. Flexural Strength (ASTM D790): 20,386 (psi)

    c. Flexural Modulus (ASTM D790): 920,271 (psi)

    d. Tensile Modulus (ASTM D638): 1,277,218 (psi)

    e. Barcol Hardness: 45

    f. Burning Characteristics (ASTM E84): <150 Flame Spread
    <1,000 Smoke Density

g. Izod Impact - Notched ((ft.-lbs)/in): 16.30

h. Izod Impact - Unnotched ((ft.-lbs)/in): 21.79

2. Core Properties (Atlas Sheathing):

a. Flame Spread (ASTM E84): <75

b. Smoke Development (ASTM E84): <450

D. Each wall panel shall be overlapped at the corner and form an internal connection joint using stainless steel hardware spaced no less than every 12" on center. Every external right hand side of every wall panel will incorporate a mitered 3/4" plywood strip used for fastening one wall panel to another using 1" #14 stainless steel hex wood screws, creating a seamless exterior appearance. All wall panel joints shall be thoroughly sealed with matching silicone caulk. The enclosure shall have a minimum R-19 insulation (2.5" foam core) factor and a factory wind load rating of 100 mph.

E. The wall sections shall be engineered and fabricated with vertical FiberBeam laminations located between the inner and outer FRP skins to provide added structural integrity and prevent de-lamination of the foam core and fiberglass skins.

F. All exterior surfaces shall be brick textured with 18-20 mils of high quality isopthalic gel coat, incorporating ultra violet inhibitors.

G. All interior surfaces shall be sprayed with 18-20 mils of high quality isopthalic white gel coat finish offering the same characteristics as the exterior surfaces without the ultra-violet inhibitors. Color shall be selected from manufacturers standard color selection.

H. The roof panel shall be a one-piece vaulted "hip" design, incorporating the same materials of construction as the side walls. All four sides of the roof flange will incorporate a mitered 3/4" plywood strip used for fastening the roof to the wall panels using 1" #14 stainless steel hex wood screws creating a seamless appearance. The roof flanges overlap the top of the wall flanges creating a weather-proof joint, which is also sealed with silicone caulk. The 17 degree pitch of the roof shall be sufficient for good moisture drainage, and withstand a minimum snow load of 30 pounds per square foot. The roof shall overlap the top wall flange and connect to the wall using stainless steel hardware spaced no less than every 12" on center. The roof shall be engineered and fabricated with vertical FiberBeam laminations located between the inner and outer FRP skins to provide added structural integrity and prevent de-lamination of the foam core and fiberglass skins.

I. The enclosure shall be provided with a 4 3/4" interior fiberglass base flange for mounting to the concrete slab by the installing contractor. The fully assembled enclosure shall be positioned on the concrete mounting pad and sealed with butyl tape. The interior base flange shall be

drilled, positioned and fastened to the pad using Type 316 stainless steel expansion anchors on 12" centers (anchor bolts to be provided by the installing contractor).

2.1.2 Doors

A. The enclosure shall be provided with one double door opening. Each door shall be 3'-0" wide x 6'-8".

1. The doors shall be constructed of the same laminated fiberglass and foam core materials and be completely compatible with the enclosure.

2. The doors shall have a standard threshold.

3. The doors shall be hung with three (3) 4.5" x 4.5" stainless steel ball bearing type hinges equipped with non-removable pins. The hinges shall be bolted through the door jab with stainless steel fasteners into a door jamb already reinforced with 3/4 inch plywood. Hinges shall be oriented in the full-mortised position with no fasteners exposed when door is in the closed position.

4. A 2-point closure system shall be used and the doors shall be held tight to the enclosure at the top, and bottom.

5. The doors shall be sealed with a weather-tight neoprene gasket along the entire perimeter of the door.

6. The doors and all hardware shall be able to withstand 100 mph winds.

7. A wall-mounted drip molding shall be located above each door.

PART 3 EXECUTION

3.1 GENERAL

Construct concrete pad complying with the Drawings and applicable Sections of these Specifications.

3.2 INSTALLATION OF FIBERGLASS ENCLOSURE

A. Locate fiberglass enclosure as indicated on Drawings or located by the COR.

1. Enclosure shall be placed on slab, marked for proper alignment, removed, install gasketing and re-placed on slab before permanent bolting is secured.

B. Block and shim as necessary to place at proper elevation plumb and level.

C. Snug down anchor bolt nuts and grout uneven places beneath enclosure base using non-shrink grout.

## 3.3 MEASUREMENT AND PAYMENT

No separate measurement or direct payment will be made for this work and all costs for same shall be included in the price bid for the work to which it pertains.

-- End of Section 13 12 10 --

SECTION 13 34 19
METAL BUILDING SYSTEMS

PART 1 GENERAL

1.1 REFERENCES

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

ALUMINUM ASSOCIATION (AA)

| | |
|---|---|
| AA ADM | (2010) Aluminum Design Manual |
| AA ASD1 | (2013) Aluminum Standards and Data |

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

| | |
|---|---|
| AISC 325 | (2011) Steel Construction Manual |
| AISC 341 | (2010) Seismic Provisions for Structural Steel Buildings |
| AISC 360 | (2010) Specification for Structural Steel Buildings |

AMERICAN IRON AND STEEL INSTITUTE (AISI)

| | |
|---|---|
| AISC/AISI 121 | (2004) Standard Definitions for Use in the Design of Steel Structures |
| AISI SG03-3 | (2002; Suppl 2001-2004; R 2008) Cold-Formed Steel Design Manual Set |

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

| | |
|---|---|
| ASCE 7 | (2010; Errata 2011; Supp 1 2013) Minimum Design Loads for Buildings and Other Structures |

AMERICAN WELDING SOCIETY (AWS)

| | |
|---|---|
| AWS A5.1/A5.1M | (2012) Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding |
| AWS D1.1/D1.1M | (2010; Errata 2011) Structural Welding Code - Steel |
| AWS D1.3/D1.3M | (2008; Errata 2008) Structural Welding Code - Sheet Steel |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A1008/A1008M | (2013) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardened |
| ASTM A1011/A1011M | (2014) Standard Specification for Steel, Sheet, and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability and Ultra-High Strength |
| ASTM A123/A123M | (2013) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products |
| ASTM A153/A153M | (2009) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware |
| ASTM A193/A193M | (2014) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications |
| ASTM A307 | (2012) Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength |
| ASTM A325 | (2010; E 2013) Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength |
| ASTM A36/A36M | (2012) Standard Specification for Carbon Structural Steel |
| ASTM A463/A463M | (2010) Standard Specification for Steel Sheet, Aluminum-Coated, by the Hot-Dip Process |
| ASTM A500/A500M | (2013) Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes |
| ASTM A501 | (2007) Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing |
| ASTM A529/A529M | (2005; R 2009) Standard Specification for High-Strength Carbon-Manganese Steel of Structural Quality |
| ASTM A53/A53M | (2012) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless |

| | |
|---|---|
| ASTM A563 | (2007a; R2014) Standard Specification for Carbon and Alloy Steel Nuts |
| ASTM A563M | (2007; R 2013) Standard Specification for Carbon and Alloy Steel Nuts (Metric) |
| ASTM A572/A572M | (2013a) Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel |
| ASTM A606/A606M | (2009a) Standard Specification for Steel Sheet and Strip, High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, with Improved Atmospheric Corrosion Resistance |
| ASTM A653/A653M | (2013) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process |
| ASTM A755/A755M | (2011) Standard Specification for Steel Sheet, Metallic Coated by the Hot-Dip Process and Prepainted by the Coil-Coating Process for Exterior Exposed Building Products |
| ASTM A780/A780M | (2009) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings |
| ASTM A792/A792M | (2010) Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process |
| ASTM A992/A992M | (2011) Standard Specification for Structural Steel Shapes |
| ASTM B117 | (2011) Standard Practice for Operating Salt Spray (Fog) Apparatus |
| ASTM B209 | (2010) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate |
| ASTM B221 | (2013) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes |
| ASTM B221M | (2013) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric) |
| ASTM B695 | (2004; R 2009) Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel |

| | |
|---|---|
| ASTM C665 | (2012) Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing |
| ASTM C920 | (2014a) Standard Specification for Elastomeric Joint Sealants |
| ASTM D1056 | (2014) Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber |
| ASTM D1308 | (2013) Effect of Household Chemicals on Clear and Pigmented Organic Finishes |
| ASTM D1667 | (2005; R 2011) Flexible Cellular Materials - Poly (Vinyl Chloride) Foam (Closed-Cell) |
| ASTM D2244 | (2014) Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates |
| ASTM D2247 | (2011) Testing Water Resistance of Coatings in 100% Relative Humidity |
| ASTM D2794 | (1993; R 2010) Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact) |
| ASTM D3363 | (2005; E 2011; R 2011; E 2012) Film Hardness by Pencil Test |
| ASTM D4214 | (2007) Standard Test Method for Evaluating the Degree of Chalking of Exterior Paint Films |
| ASTM D522/D522M | (2014) Mandrel Bend Test of Attached Organic Coatings |
| ASTM D523 | (2014) Standard Test Method for Specular Gloss |
| ASTM D714 | (2002; R 2009) Evaluating Degree of Blistering of Paints |
| ASTM D822 | (2001; R 2006) Filtered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings |
| ASTM D968 | (2005; R 2010) Abrasion Resistance of Organic Coatings by Falling Abrasive |
| ASTM DEFONLINE | (2008) ASTM Online Dictionary of Engineering Science and Technology |

| | |
|---|---|
| ASTM E1592 | (2005; R 2012) Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference |
| ASTM E1646 | (1995; R 2011) Standard Test Method for Water Penetration of Exterior Metal Roof Panel Systems by Uniform Air Pressure Difference |
| ASTM E331 | (2000; R 2009) Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference |
| ASTM E84 | (2014) Standard Test Method for Surface Burning Characteristics of Building Materials |
| ASTM E96/E96M | (2013) Standard Test Methods for Water Vapor Transmission of Materials |
| ASTM F1554 | (2007a; E 2011) Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength |
| ASTM F1852 | (2011) Standard Specification for "Twist Off" Type Tension Control Structural Bolt/Nut/Washer Assemblies, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength |
| ASTM F436 | (2011) Hardened Steel Washers |
| ASTM F844 | (2007a; R 2013) Washers, Steel, Plain (Flat), Unhardened for General Use |
| ASTM G152 | (2013) Operating Open Flame Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials |
| ASTM G153 | (2013) Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials |

METAL BUILDING MANUFACTURERS ASSOCIATION (MBMA)

| | |
|---|---|
| MBMA MBSM | (2002) Metal Building Systems Manual |

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

| | |
|---|---|
| NAAMM AMP 500 | (2006) Metal Finishes Manual |

NATIONAL ROOFING CONTRACTORS ASSOCIATION (NRCA)

| | |
|---|---|
| NRCA RoofMan | (2011 thru 2014) The NRCA Roofing Manual |

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

| | |
|---|---|
| SMACNA 1793 | (2012) Architectural Sheet Metal Manual, 7th Edition |

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

| | |
|---|---|
| SSPC Paint 15 | (1999; E 2004) Steel Joist Shop Primer |
| SSPC Painting Manual | (2002) Good Painting Practice, Steel Structures Painting Manual, Volume 1, Edition 4 |
| SSPC SP 2 | (1982; E 2000; E 2004) Hand Tool Cleaning |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 580 | (2006; Reprint Oct 2013) Tests for Uplift Resistance of Roof Assemblies |

## 1.2 GENERAL REQUIREMENTS

### 1.2.1 Structural Performance

Provide metal building systems capable of withstanding the effects of gravity loads and the following loads and stresses within the limits and conditions indicated.

#### 1.2.1.1 Engineering

Design metal building systems conforming to procedures described in MBMA MBSM.

#### 1.2.1.2 Design Loads

Conform to the requirements of MBMA MBSM, ASCE 7, and the building code applicable to the project geographical location.

#### 1.2.1.3 Live Loads

Include all vertical loads induced by the building occupancy indicated on the drawings, as well as loads induced by maintenance workers, materials and equipment for roof live loads.

1.2.1.4 Roof Snow Loads

Include vertical loads induced by the weight of snow, as determined by 50 year Mean-Recurrence-Interval (MRI) ground snow load at the project site of Hobucken, NC. Allow for unbalanced and drift loads.

1.2.1.5 Wind Loads

Include horizontal loads induced by a basic wind speed corresponding to a 50-year, mean-recurrence interval at Project site of Hobucken, NC.

1.2.1.6 Collateral Loads

Include additional dead loads other than the weight of metal building system for permanent items such as sprinklers, mechanical systems, electrical systems, and ceilings.

1.2.1.7 Load Combinations

Design metal building systems to withstand the most critical effects of load factors and load combinations as required by MBMA MBSM, ASCE 7, and the building code applicable to the project location.

1.2.1.8 Deflection Limits

Engineer assemblies to withstand design loads with deflections no greater than the following:

a. Purlins and Rafters; vertical deflection of 1/180 of the span.

b. Girts; horizontal deflection of 1/180 of the span.

c. Metal Roof Panels; vertical deflection of 1/180 of the span.

d. Metal Wall Panels; horizontal deflection of 1/180 of the span.

Design secondary framing system to accommodate deflection of primary building structure and construction tolerances, and to maintain clearances at openings. Provide metal panel assemblies capable of withstanding the effects of loads and stresses indicated, based on testing according to ASTM E1592.

1.2.2 Seismic Performance

Design and engineer metal building system capable of withstanding the effects of earthquake motions determined according to ASCE 7, AISC 341, and the applicable portions of the building code in the geographic area where the construction will take place.

1.2.3 Thermal Movements

Provide metal panel systems that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss as follows:

Temperature Change (Range); 120 F, ambient; 180 F, material surfaces.

1.2.4 Thermal Performance

Provide metal building manufacturers standard fiberglass insulation blankets with facing at roof and wall panels to control condensation.

1.2.5 Water Penetration for Metal Roof Panels

No water penetration when tested according to ASTM E1646 at test-pressure difference of 2.86 lbf/sq.ft..

1.2.6 Water Penetration for Metal Wall Panels

No water penetration when tested according to ASTM E331 at a minimum differential pressure of 20 percent of inward-acting, wind-load design pressure of not less than 6.24 lbf/sq.ft. and not more than 12 lbf/sq. ft.

1.2.7 Wind-Uplift Resistance

Provide metal roof panel assemblies that comply with UL 580 for Class 90.

1.3 DEFINITIONS

ASTM DEFONLINE applies to this definition paragraph.

a. Bay: Dimension between main frames measured normal to frame (at centerline of frame) for interior bays, and dimension from centerline of first interior main frame measured normal to end wall (outside face of end-wall girt) for end bays.

b. Building Length: Dimension of the building measured perpendicular to main framing from end wall to end wall (outside face of girt to outside face of girt).

c. Building Width: Dimension of the building measured parallel to main framing from sidewall to sidewall (outside face of girt to outside face of girt).

d. Clear Span: Distance between supports of beams, girders, or trusses (measured from lowest level of connecting area of a column and a rafter frame or knee).

e. Eave Height: Vertical dimension from finished floor to eave (the line along the sidewall formed by intersection of the planes of the roof and wall).

f. Clear Height under Structure: Vertical dimension from finished floor to lowest point of any part of primary or secondary structure, not including crane supports, located within clear span.

g. Terminology Standard: Refer to MBMA "Metal Building Systems Manual" for definitions of terms for metal building system construction not otherwise defined in this Section or in referenced standards.

1.4 SYSTEM DESCRIPTION

General: Provide a complete, integrated set of metal building system manufacturer's standard mutually dependent components and assemblies that form a metal building system capable of withstanding structural and other loads, thermally induced movement, and exposure to weather without failure or infiltration of water into building interior. Include primary and secondary framing, metal roof panels, metal wall panels, and accessories complying with requirements indicated.

Provide metal building system of size and with spacing, slopes, and spans indicated.

1.4.1 Primary Frame Type

a. Rigid Clear Span: Solid-member, structural-framing system without interior columns.

1.4.2 Fixed End-Wall Framing

Provide manufacturer's standard fixed end wall, for buildings not required to be expandable.

1.4.3 Secondary Frame Type

Provide manufacturer's standard purlins and joists and exterior-framed (bypass) girts.

1.4.4 Eave Height

Eave height must be 17 feet, as indicated by nominal height on drawings.

1.4.5 Bay Spacing

Bay Spacing must be as indicated on drawings.

1.4.6 Roof Slope

Roof slope must be 2 inches per 12 inches as indicated on the drawings.

1.4.7 Roof System

Provide manufacturer's standard vertical-rib, standing-seam or trapezoidal-rib standing-seam metal roof panels with insulation.

1.4.8 Exterior Wall System

Provide manufacturer's standard field-assembled, insulated or field-assembled, un-insulated metal wall panels with standard fiberglass blankets complete with vapor barrier conforming to ASTM E96/E96M.

1.5 SUBMITTALS

Contracting Officer's written approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Manufacturer's Qualifications

SD-02 Shop Drawings

Detail Drawings

SD-03 Product Data

Manufacturer's catalog data

SD-04 Samples

Manufacturer's color charts and chips, 4 by 4 inches

SD-05 Design Data

Manufacturer's descriptive and technical literature

Manufacturer's building design analysis

SD-06 Test Reports

test reports

Coatings and base metals

Factory Color Finish Performance Requirements

SD-07 Certificates

System components

Galvanizing Repair Paint

Qualification of Manufacturer

Qualification of Erector

SD-08 Manufacturer's Instructions

Metal Wall Panel Installation

Roof Panel Installation

Shipping, handling, and storage

SD-11 Closeout Submittals

Building System Standard Warranty

Roof System Weather-Tightness Standard Warranty

Roof and Wall Panel Finish Standard Warranty

Manufacturer's Standard Warranty

Contractor's Standard Warranty for Installation

## 1.6 QUALITY ASSURANCE

### 1.6.1 Pre-Erection Conference

After submittals are received and approved but before metal building system work, including associated work, is performed, the Contracting Officer will hold a pre-erection conference to review the following:

a. The detail drawings, specifications, and manufacturer's descriptive and technical literature.

b. Finalize construction schedule and verify availability of materials, erector's personnel, equipment, and facilities needed to make progress and avoid delays.

c. Methods and procedures related to metal building system erection, including, but not limited to: qualification of manufacturer, qualification of erector, manufacturer's catalog data, building design analysis, written instructions and test reports.

d. Support conditions for compliance with requirements, including alignment between and erection of structural members.

e. Flashing, special roofing and siding details, roof and wall penetrations, openings, and condition of other construction that will affect metal building system, including coatings and base metals, factory color finish performance requirements, system components, and certificates for coil stock.

f. Governing regulations and requirements for, certificates, insurance, tests and inspections if applicable.

g. Temporary protection requirements for metal panel assembly during and after installation.

h. Samples of galvanizing repair paint.

1.6.2 Manufacturer's Technical Representative

The representative must have authorization from manufacturer to approve field changes and be thoroughly familiar with the products, erection of structural framing and installation of roof and wall panels in the geographical area where construction will take place.

1.6.3 Manufacturer's Qualifications

Metal building system manufacturer must have a minimum of five (5) years experience as a qualified manufacturer and a member of MBMA of metal building systems and accessory products.

Provide engineering services by an authorized currently licensed engineer in the geographical area where construction will take place, having a minimum of four years experience as an engineer knowledgeable in building design analysis, protocols and procedures for the "Metal Building Systems Manual" (MBMA MBSM); ASCE 7, the building code in the geographic area where the construction will take place and ASTM E1592.

Provide certified engineering calculations using the products submitted for:

a. Roof and Wall Wind Loads with basic wind speed, exposure category, co-efficient, importance factor, designate type of facility, negative pressures for each zone, methods and requirements of attachment.

b. Roof Dead and Live Loads

c. Collateral Loads

d. Foundation Loads

e. Roof Snow Load

1.6.4 Qualification of Erection Contractor

An experienced erector who has specialized in erecting and installing work similar in material, design, and extent to that indicated for this Project and must be approved and certified by the metal building system manufacturer.

1.6.5 Single Source

Obtain primary and secondary components and structural framing members, each type of metal roof, wall and liner panel assemblies, clips, closures and other accessories from the standard products of the single source from a single manufacturer to operate as a complete system for the intended use.

1.6.6 Welding

Qualify procedures and personnel according to AWS A5.1/A5.1M, AWS D1.1/D1.1M, and AWS D1.3/D1.3M.

1.6.7 Structural Steel

Comply with AISC 325 and AISC 360, for design requirements and allowable stresses.

1.6.8 Cold-Formed Steel

Comply with AISC/AISI 121 and AISI SG03-3 for design requirements and allowable stresses.

1.6.9 Surface-Burning Characteristics

Provide metal panels having insulation and vapor barrier material with the following surface-burning characteristics as determined by testing identical products according to ASTM E84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency showing:

a. Flame-Spread Index: 25 or less.
b. Smoke-Developed Index: 450 or less.

1.6.10 Fabrication

Fabricate and finish metal panels and accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes and as necessary to fulfill indicated

performance requirements. Comply with indicated profiles with dimensional and structural requirements

Provide metal panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel. Aluminum and aluminum-alloy sheet and plate must conform to ASTM B209.

Fabricate metal panel side laps with factory-installed captive gaskets or separator strips that provide a tight seal and prevent metal-to-metal contact, in a manner that will seal weather-tight and minimize noise from movements within panel assembly.

Sheet Metal Accessories: Fabricate flashing and trim to comply with recommendations in SMACNA 1793 that apply to the design, dimensions, metal, and other characteristics of item indicated:

a. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.

b. End Seams: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.

c. Sealed Joints: Form non-expansion but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA standards.

d. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.

e. Fabricate cleats and attachment devices of size and metal thickness recommended by SMACNA or by metal building system manufacturer for application, but not less than thickness of metal being secured.

1.6.11 Finishes

Comply with NAAMM AMP 500 for recommendations for applying and designating finishes.

Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

1.7 SHIPPING, HANDLING AND STORAGE

1.7.1 Delivery

Package and deliver components, sheets, metal panels, and other manufactured items so as not to be damaged or deformed and protected during transportation and handling.

Stack and store metal panels horizontally on platforms or pallets, covered with suitable weather-tight and ventilated covering to ensure dryness, with positive slope for drainage of water. Store in a manner to prevent bending, warping, twisting, and surface damage. Do not store metal wall panels in contact with other materials that might cause staining, denting, or other surface damage. Retain strippable protective covering on metal panel for entire period up to metal panel installation.

Complete installation and concealment of plastic materials as rapidly as possible in each area of construction to minimize ultraviolet exposure.

## 1.8 PROJECT CONDITIONS

### 1.8.1 Weather Limitations

Proceed with installation preparation only when existing and forecasted weather conditions permit Work to proceed without water entering into existing panel system or building.

### 1.8.2 Field Measurements

#### 1.8.2.1 Established Dimensions for Foundations

Comply with established dimensions on approved anchor-bolt plans, established foundation dimensions, and proceed with fabricating structural framing. Do not proceed without verifying field measurements. Coordinate anchor-bolt installation to ensure that actual anchorage dimensions correspond to established dimensions.

#### 1.8.2.2 Established Dimensions for Metal Panels

Where field measurements cannot be made without delaying the Work, either establish framing and opening dimensions and proceed with fabricating metal panels without field measurements, or allow for field trimming metal panels. Coordinate construction to ensure that actual building dimensions, locations of structural members, and openings correspond to established dimensions.

#### 1.8.2.3 Verification Record

Verify locations of all framing and opening dimensions by field measurements before metal panel fabrication and indicate measurements on Shop Drawings.

## 1.9 COORDINATION

Coordinate size and location of concrete foundations and casting of anchor-bolt inserts into foundation walls and footings. Concrete, reinforcement, and formwork requirements are specified in section on CAST-IN-PLACE CONCRETE.

Coordinate installation of plumbing system, equipment supports, piping and supports and accessories, which are specified in Division 22 - PLUMBING.

Coordinate installation of HVAC system, equipment supports, ductwork and supports, piping and supports and accessories, which are specified in Division 23 - HEATING, VENTILATING AND AIR-CONDITIONING (HVAC).

Coordinate metal panel assemblies with rain drainage work, flashing, trim, and construction of supports and other adjoining work to provide a leak-proof, secure, and non-corrosive installation.

## 1.10 STANDARD WARRANTY

### 1.10.1 Building System Standard Warranty

Furnish manufacturer's no-dollar-limit warranty for the metal building system. The warranty period is to be no less than 20 years from the date of acceptance of the work and be issued directly to the Government. The warranty must provide that if within the warranty period, the metal building system shows evidence of deterioration resulting from defective materials and/or workmanship, correcting of any defects is the responsibility of the metal building system manufacturer. Repairs that become necessary because of defective materials and workmanship while metal building system is under warranty are to be performed within 32 hours after notification, unless additional time is approved by the Contracting Officer. Failure to perform repairs within 32 hours of notification will constitute grounds for having emergency repairs performed by others and will not void the warranty.

### 1.10.2 Roof System Weather-Tightness Standard Warranty

Furnish manufacturer's no-dollar-limit warranty for the metal panel system. The warranty period is to be no less than 20 years from the date of acceptance of the work and be issued directly to the Government.

The warranty is to provide that if within the warranty period the roof panel system shows evidence of corrosion, perforation, rupture, lost of weather-tightness or excess weathering due to deterioration of the panel system resulting from defective materials and correction of the defective workmanship is to be the responsibility of the metal building system manufacturer.

Repairs that become necessary because of defective materials and workmanship while roof panel system is under warranty are to be performed within 24 hours after notification, unless additional time is approved by the Contracting Officer. Failure to perform repairs within 24 hours of notification will constitute grounds for having emergency repairs performed by others and not void the warranty. Immediate follow-up and completion of permanent repairs must be performed within 5 days from date of notification.

### 1.10.3 Roof and Wall Panel Finish Standard Warranty

Furnish manufacturer's no-dollar-limit warranty for the metal panel system. The warranty period is to be no less than 20 years from the date of acceptance of the work and be issued directly to the Government.

The warranty is to provide that if within the warranty period the metal panel system shows evidence of checking, delaminating cracking, peeling, chalk in excess of a numerical rating of eight, as determined by ASTM D4214 test procedures; or change colors in excess of five CIE or Hunter units in accordance with ASTM D2244 or excess weathering due to deterioration of the panel system resulting from defective materials and finish or correction of the defective workmanship is to be the responsibility of the metal building system manufacturer.

Liability under this warranty is exclusively limited to replacing the defective coated materials.

Repairs that become necessary because of defective materials and workmanship while roof and wall panel system is under warranty are to be performed within 32 hours after notification, unless additional time is approved by the Contracting Officer. Failure to perform repairs within 32 hours of notification will constitute grounds for having emergency repairs performed by others and not void the warranty.

## PART 2 PRODUCTS

### 2.1 STRUCTURAL FRAMING MATERIALS

#### 2.1.1 W-Shapes

ASTM A992/A992M; ASTM A572/A572M or ASTM A529/A529M.

#### 2.1.2 Channel, Angles, M-Shapes and S-Shapes

ASTM A36/A36M; ASTM A572/A572M or ASTM A529/A529M.

#### 2.1.3 Plate and Bar

ASTM A36/A36M, ASTM A572/A572M or ASTM A529/A529M.

#### 2.1.4 Steel Pipe

ASTM A36/A36M, ASTM A53/A53M, ASTM A572/A572M or ASTM A529/A529M.

#### 2.1.5 Cold-Formed and Hot Formed Hollow Structural Sections

Cold formed:ASTM A500/A500M or ASTM B221, ASTM B221M. Hot-formed: ASTM A501.

#### 2.1.6 Structural-Steel Sheet

Hot-rolled, ASTM A1011/A1011M or cold-rolled, ASTM A1008/A1008M.

#### 2.1.7 Metallic-Coated Steel Sheet

ASTM A653/A653M, ASTM A606/A606M.

2.1.8 Metallic-Coated Steel Sheet Pre-painted with Coil Stock Coating

Steel sheet metallic coated by the hot-dip process and pre-painted by the coil-coating process to comply with ASTM A755/A755M.

a. Zinc-Coated (Galvanized) Steel Sheet: ASTM A653/A653M, and ASTM A123/A123M.

b. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A792/A792M, and ASTM A463/A463M.

2.1.9 High-Strength Bolts, Nuts, and Washers

ASTM A325, heavy hex steel structural bolts; ASTM A563 heavy hex carbon-steel nuts; and ASTM F436 hardened carbon-steel washers.

Finish: Hot-dip zinc coating, ASTM A153/A153M or Mechanically deposited zinc coating, ASTM B695.

Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F1852, heavy-hex-head steel structural bolts with spline.

Finish: Mechanically deposited zinc coating, ASTM B695 or Mechanically deposited zinc coating, ASTM B695 baked epoxy coated.

2.1.10 Non-High-Strength Bolts, Nuts, and Washers

ASTM A307, ASTM A563, and ASTM F844.

Finish: ASTM A153/A153M or ASTM B695.

2.1.11 Anchor Rods

ASTM F1554.

a. Configuration: Straight.
b. Nuts: ASTM A563 heavy hex carbon steel.
c. Plate Washers: ASTM A36/A36M carbon steel.
d. Washers: ASTM F436 hardened carbon steel.
e. Finish: Hot-dip zinc coating, ASTM A153/A153M or Mechanically deposited zinc coating, ASTM B695.

2.1.12 Threaded Rods

ASTM A193/A193M.

a. Nuts: ASTM A563 heavy hex carbon steel.
b. Washers: ASTM F436 hardened or ASTM A36/A36M carbon steel.
c. Finish: Hot-dip zinc coating, ASTM A153/A153M or Mechanically deposited zinc coating, ASTM B695.

2.1.13 Primer

SSPC-Paint 15, Type I, red oxide.

2.2 FABRICATION

2.2.1 General

Comply with MBMA MBSM - "Metal Building Systems Manual": Chapter IV, Section 9, "Fabrication and Erection Tolerances."

2.3 STRUCTURAL FRAMING

2.3.1 General

Clean all framing members to remove loose rust and mill scale. Provide 1 shop coat of primer to an average dry film thickness of 1 mil according to SSPC SP 2. Balance of painting and coating procedures must conform to SSPC Paint 15 and SSPC Painting Manual. Bracing shall not be located where it conflicts with the windows, doors or the function of the facitlity.

2.3.2 Primary Framing

Manufacturer's standard structural primary framing system includes transverse and lean-to frames; rafter, rakes, and canopy beams; sidewall, intermediate, end-wall, and corner columns; and wind bracing designed to withstand required loads and specified requirements. Provide frames with attachment plates, bearing plates, and splice members. Provide frame span and spacing indicated.

Shop fabricate framing components by welding or by using high-strength bolts to the indicated size and section with base-plates, bearing plates, stiffeners, and other items required. Cut, form, punch, drill, and weld framing for bolted field erection.

a. Rigid Clear-Span Frames: I-shaped frame sections fabricated from shop-welded, built-up steel plates or structural-steel shapes. Interior columns are not permitted.

b. Frame Configuration: Single gable.

d. Exterior Column Type: Uniform depth.

e. Rafter Type: Uniform depth.

2.3.3 Secondary Framing

Manufacturer's standard secondary framing members, including purlins, girts, eave struts, flange bracing, base members, gable angles, clips, headers, jambs, and other miscellaneous structural members. Fabricate framing from cold-formed, structural-steel sheet or roll-formed, metallic-coated steel sheet pre-painted with coil coating, unless otherwise indicated.

Shop fabricate framing components by roll-forming or break-forming to the indicated size and section with base-plates, bearing plates, stiffeners, and other plates required for erection. Cut, form, punch, drill, and weld secondary framing for bolted field connections to primary framing.

a. Purlins: C or Z-shaped sections; fabricated from steel sheet, built-up steel plates, or structural-steel shapes; minimum depth as required to comply with system performance requirements.

b. Girts: C or Z-shaped sections; fabricated from steel sheet, built-up steel plates, or structural-steel shapes. Form ends of Z-sections with stiffening lips angled 40 to 50 degrees to flange minimum depth as required to comply with system performance requirements.

c. Eave Struts: Unequal-flange, C-shaped sections; fabricated from steel sheet, built-up steel plates, or structural-steel shapes; to provide adequate backup for metal panels.

d. Flange Bracing: Structural-steel angles or cold-formed structural tubing to stiffen primary frame flanges.

e. Sag Bracing: Structural-steel angles.

f. Base or Sill Angles: Zinc-coated (galvanized) steel sheet.

g. Purlin and Girt Clips: Steel sheet. Provide galvanized clips where clips are connected to galvanized framing members.

h. Secondary End-Wall Framing: Manufacturer's standard sections fabricated from zinc-coated (galvanized) steel sheet.

i. Framing for Openings: Channel shapes; fabricated cold-formed, structural-steel sheet or structural-steel shapes. Frame head and jamb of door openings, and head, jamb, and sill of other openings.

j. Miscellaneous Structural Members: Manufacturer's standard sections fabricated from cold-formed, structural-steel sheet; built-up steel plates; or zinc-coated (galvanized) steel sheet; designed to withstand required loads.

2.3.4 Bracing

Provide adjustable wind bracing as follows:

a. Rods: ASTM A36/A36M; ASTM A572/A572M; or ASTM A529/A529M threaded full length at each end.

b. Angles: Fabricated from structural-steel shapes to match primary framing, of size required to withstand design loads.

c. Rigid Portal Frames: Fabricate from shop-welded, built-up steel plates or structural-steel shapes to match primary framing; of size required to withstand design loads.

d. Fixed-Base Columns: Fabricate from shop-welded, built-up steel plates or structural-steel shapes to match primary framing; of size required to withstand design loads.

e. Diaphragm Action of Metal Panels: Design metal building to resist wind forces through diaphragm action of metal panels.

f. Bracing: Provide wind bracing using any method specified above, at manufacturer's option. Provide bracing that will not interfere with indicated openings and added components such as coiling doors.

2.4 PANEL MATERIALS

2.4.1 Aluminum Sheet

Roll-form aluminum roof, wall and liner panels to the specified profile, with fy = .040 inch thickness and depth as indicated. Material must be plumb and true, and within the tolerances listed:

a. Aluminum Sheet conforming to ASTM B209, AA ADM and AA ASD1.

b. Individual panels to have continuous length to cover the entire length of any roof slope or wall area with no joints or seams and formed without warping, waviness, or ripples that are not part of the panel profile and free of damage to the finish coating system.

c. Provide panels with thermal expansion and contraction consistent with the type of system specified.

1. Profile and coverage to be a minimum height and width from manufacturer's standard for the indicated roof slope or wall area.

2. Profile to be a 1-1/2 inch high rib at 12 inches o.c. with small stiffening ribs, 38 inch overall width with 36 inch coverage and exposed fasteners.

OR

3. Profile to be a 1-1/2 inch high rib at 7.2 inches o.c., 38-7/8 inch overall width with 36 inch coverage and exposed fasteners.

2.4.2 Steel Sheet

Roll-form steel roof, wall and liner panels to the specified profile, with fy = 24 gauge and depth as indicated. Material must be plumb and true, and within the tolerances listed:

a. Galvanized Steel Sheet conforming to ASTM A653/A653M and AISI SG03-3.

b. Aluminum-Zinc Alloy-coated Steel Sheet conforming to ASTM A792/A792M and AISI SG03-3.

c. Individual panels to have continuous length to cover the entire length of any unbroken roof slope or wall area with no joints or seams and formed without warping, waviness, or ripples that are not part of the panel profile and free of damage to the finish coating system.

d. Provide panels with thermal expansion and contraction consistent with the type of system specified;

profile and coverage to be a minimum height and width from manufacturer's standard for the indicated roof slope or wall area.

profile to be a 1-1/2 inch high rib at 12 inches o.c. with small stiffening ribs, 38 inch overall width with 36 inch coverage and exposed fasteners.

OR

profile to be a 1-1/2 inch high rib at 7.2 inches o.c., 38-7/8 inch overall width with 36 inch coverage and exposed fasteners.

2.4.3 Finish

All panels are to receive a factory-applied polyvinylidene fluoride or Kynar 500/Hylar 5000 finish consisting of a baked-on top-coat with a manufacturer's recommended prime coat conforming to the following:

a. Metal Preparation: All metal is to have the surfaces carefully prepared for painting on a continuous process coil coating line by alkali cleaning, hot water rinsing, application of chemical conversion coating, cold water rinsing, sealing with acid rinse, and thorough drying.

b. Prime Coating: A base coat of epoxy paint, specifically formulated to interact with the top-coat, is to be applied to the prepared surfaces by roll coating to a dry film thickness of 0.20 plus 0.05 mils. This prime coat must be oven cured prior to application of finish coat.

c. Exterior Finish Coating: Apply the finish coating over the primer by roll coating to dry film thickness of 0.80 plus 5 mils (3.80 plus 0.50 mils for Vinyl Plastisol) for a total dry film thickness of 1.00 plus 0.10 mils (4.00 plus 0.10 mils for Vinyl Plastisol). This finish coat must be oven-cured.

d. Interior Finish Coating: Apply a wash-coat on the reverse side over the primer by roll coating to a dry film thickness of 0.30 plus 0.05 mils for a total dry film thickness of 0.50 plus 0.10 mils. The wash-coat must be oven-cured.

e. Color: The exterior finish chosen from the manufacturer's color charts and chips.

f. Physical Properties: Coating must conform to the industry and manufacturer's standard performance criteria as listed by the following certified test reports:

Chalking: ASTM DEFONLINE
Color Change and Conformity: ASTM D2244
Weatherometer: ASTM G152, ASTM G153 and ASTM D822
Humidity: ASTM D2247 and ASTM D714
Salt Spray: ASTM B117
Chemical Pollution: ASTM D1308
Gloss at 60 degrees: ASTM D523
Pencil Hardness: ASTM D3363
Reverse Impact: ASTM D2794
Flexibility: ASTM D522/D522M
Abrasion: ASTM D968
Flame Spread: ASTM E84

2.4.4 Repair Of Finish Protection

Repair paint for color finish enameled metal panel must be compatible paint of the same formula and color as the specified finish furnished by the metal panel manufacturer, conforming to ASTM A780/A780M.

2.5 MISCELLANEOUS METAL FRAMING

2.5.1 General

Cold-formed metallic-coated steel sheet conforming to ASTM A653/A653M.

2.5.2 Fasteners for Miscellaneous Metal Framing

Refer to the following paragraph "FASTENERS".

## 2.6 FASTENERS

### 2.6.1 General

Type, material, corrosion resistance, size and sufficient length to penetrate the supporting member a minimum of 1 inch with other properties required to fasten miscellaneous metal framing members to substrates in accordance with the metal panel manufacturer's and ASCE 7 requirements.

### 2.6.2 Exposed Fasteners

Fasteners for metal panels to be corrosion resistant coated steel, aluminum, stainless steel, or nylon capped steel compatible with the sheet panel or flashing and of a type and size recommended by the manufacturer to meet the performance requirements and design loads. Fasteners for accessories to be the manufacturer's standard. Provide an integral metal washer matching the color of attached material with compressible sealing EPDM gasket approximately 3/32 inch thick.

### 2.6.3 Screws

Screws to be corrosion resistant coated steel, aluminum and/or stainless steel being the type and size recommended by the manufacturer to meet the performance requirements.

### 2.6.4 Rivets

Rivets to be closed-end type, corrosion resistant coated steel, aluminum or stainless steel where watertight connections are required.

### 2.6.5 Attachment Clips

Fabricate clips from steel hot-dipped galvanized in accordance with ASTM A653/A653M or Series 300 stainless steel. Size, shape, thickness and capacity as required meeting the insulation thickness and design load criteria specified.

## 2.7 FRAMES AND MATERIALS FOR OPENINGS

### 2.7.1 FRP Doors and Frames, Coiling Doors, and Plastic Windows

Coordinate with manufacturer to provide necessary framing for openings beyond the standard framing provided by the coor or window manufacture.

## 2.8 ACCESSORIES

### 2.8.1 General

All accessories to be compatible with the metal panels; sheet metal flashing, trim, metal closure strips, caps and similar metal accessories must not be less than the minimum thickness specified for the metal panels. Exposed metal accessories/finishes to match the panels furnished, except as otherwise indicated. Molded foam rib, ridge and other closure strips to be non-absorbent closed-cell or solid-cell synthetic rubber or pre-molded neoprene to match configuration of the panels.

2.8.2 Roof and Wall Accessories and Specialties

Aluminum ventilators, wall louvers and other miscellaneous roof and wall equipment or penetrations conforming to AAMA, ASTM, and UL.

2.8.3 Insulation

Faced, Glass-Fiber Blanket Insulation: ASTM C665, Type II, blankets with non-reflecting coverings; Class A, membrane-faced surface with a flame spread of 25 or less.

2.8.3.1 Wall Liner

Securely fasten wall liner into place in accordance with the manufacturer's recommendation and in a neatly presented appearance.

2.8.4 Rubber Closure Strips

Closed-cell, expanded cellular rubber conforming to ASTM D1056 and ASTM D1667; extruded or molded to the configuration of the specified metal panel and in lengths supplied by the metal panel manufacturer.

2.8.5 Metal Closure Strips

Factory fabricated aluminum closure strips to be the same gauge, color, finish and profile of the specified roof or wall panel.

2.8.6 2.6.6 Joint Sealants

2.8.6.1 Sealants

Sealants are to be an approved gun type for use in hand or air-pressure caulking guns at temperatures above 40 degrees F (or frost-free application at temperatures above 10 degrees F with minimum solid content of 85 percent of the total volume. Sealant is to dry with a tough, durable surface skin which permits it to remain soft and pliable underneath, providing a weather-tight joint. No migratory staining is permitted on painted or unpainted metal, stone, glass, vinyl, or wood.

Prime all joints to receive sealants with a compatible one-component or two-component primer as recommended by the metal panel manufacturer.

2.8.6.2 Shop-Applied

Sealant for shop-applied caulking must be an approved gun grade, non-sag one component polysulfide or silicone conforming to ASTM C920, Type II, and with a curing time to ensure the sealant's plasticity at the time of field erection.

2.8.6.3 Field-Applied

Sealant for field-applied caulking must be an approved gun grade, non-sag one component polysulfide or two-component polyurethane with an initial maximum Shore A durometer hardness of 25, and conforming to ASTM C920, Type II. Color to match panel colors.

2.8.6.4 Tape Sealant

Pressure sensitive, 100 percent solid with a release paper backing; permanently elastic, non-sagging, non-toxic and non-staining as approved by the metal panel manufacturer.

2.9 SHEET METAL FLASHING AND TRIM

2.9.1 Fabrication

Shop fabricate sheet metal flashing and trim where practicable to comply with recommendations in SMACNA 1793 that apply to design, dimensions, metal, and other characteristics of item indicated. Obtain field measurements for accurate fit before shop fabrication.

Fabricate sheet metal flashing and trim without excessive oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems.

2.10 FINISHES

2.10.1 General

Comply with NAAMM AMP 500 for recommendations for applying and designating finishes.

2.10.2 Appearance of Finished Work

Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 EXECUTION

3.1 EXAMINATION

Before erection proceeds examine with the erector present the concrete foundation dimensions, concrete and/or masonry bearing surfaces, anchor bolt size and placement, survey slab elevation, locations of bearing plates, and other embedment's to receive structural framing with the metal building manufacturer's templates and drawings before erecting any steel components for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

Examine primary and secondary framing to verify that rafters, purlins, angles, channels, and other structural and metal panel support members and anchorages have been installed within alignment tolerances required by metal building manufacturer, UL, ASTM, ASCE 7 and as required by the building code for the geographical area where construction will take place.

Examine roughing-in for components and systems penetrating metal roof or wall panels to verify actual locations of penetrations relative to seam locations of metal panels before metal roof or wall panel installation.

Submit to the Contracting Officer a written report, endorsed by Erector, listing conditions detrimental to performance of the Work.

Proceed with erection only after unsatisfactory conditions have been corrected.

## 3.2 PREPARATION

Provide temporary shoring, guys, braces, and other supports during erection to keep the structural framing secure, plumb, and in alignment against temporary construction loading or loads equal in intensity of the building design loads. Remove temporary support systems when permanent structural framing, connections, and bracing are in place, unless otherwise indicated.

Clean substrates of substances harmful to insulation, including removing projections capable of interfering with insulation attachment and performance.

Miscellaneous Framing: Install sub-purlins, girts, angles, furring, and other miscellaneous support members or anchorage for the metal roof or wall panels, doors, windows, roof curbs, ventilators and louvers according to metal building manufacturer's written instructions.

## 3.3 ERECTION OF STRUCTURAL FRAMING

Erect metal building system according to manufacturer's written erection instructions, approved shop drawings and other erection documents in accordance with MBMA MBSM - "Metal Building Systems Manual".

Do not field cut, drill, or alter structural members without written approval from metal building system manufacturer's professional engineer and the Contracting Officer.

Set structural framing accurately in locations and to elevations indicated and according to AISC 325 specifications. Maintain structural stability of frame during erection.

Clean and roughen concrete and masonry bearing surfaces prior to setting plates. Clean bottom surface of plates.

Align and adjust structural framing before permanent bolt-up and connections. Perform necessary adjustments and alignment to compensate for changes or discrepancies in elevations.

Maintain erection tolerances of structural framing in accordance with AISC 360.

## 3.4 METAL WALL PANEL INSTALLATION

Provide metal wall panels of full length from sill to eave as indicated, unless otherwise indicated or restricted by shipping limitations. Anchor metal wall panels and other components of the Work securely in place, in accordance with MBMA MBSM.

Erect wall panel system in accordance with the approved erection drawings, the printed instructions and safety precautions of the metal building manufacturer.

Sheets are not to be subjected to overloading, abuse, or undue impact. Do not install bent, chipped, or defective sheets.

Sheets must be erected true and plumb and in exact alignment with the horizontal and vertical edges of the building, securely anchored, and with the indicated eave, and sill.

Work is to allow for thermal movement of the wall panel, movement of the building structure, and to provide permanent freedom from noise due to wind pressure.

Field cutting metal wall panels by torch is not permitted.

## 3.5 ROOF PANEL INSTALLATION

Provide metal roof panels of full length from eave to ridge or eave to wall as indicated, unless otherwise indicated or restricted by shipping limitations. Anchor metal roof panels and other components of the Work securely in place in accordance with NRCA RoofMan and MBMA MBSM.

Erect roofing system in accordance with the approved erection drawings, the printed instructions and safety precautions of the metal building manufacturer.

Sheets are not to be subjected to overloading, abuse, or undue impact. Do not install bent, chipped, or defective sheets.

Sheets must be erected true and plumb and in exact alignment with the horizontal and vertical edges of the building, securely anchored, and with the indicated rake and eave overhang.

Work must allow for thermal movement of the roofing, movement of the building structure, and provide permanent freedom from noise due to wind pressure.

Field cutting metal roof panels by torch is not permitted.

Roofing sheets must be laid with corrugations in the direction of the roof slope. End laps of exterior roofing must not be less than 8 inches; the side laps of standard exterior corrugated sheets must not be not less than 2-1/2 corrugations.

Do not permit storage, walking, wheeling, and trucking directly on applied roofing materials. Provide temporary walkways, runways, and platforms of smooth clean boards or planks as necessary to avoid damage to the installed roofing materials, and to distribute weight to conform to the indicated live load limits of roof construction.

## 3.6 METAL PANEL FASTENER INSTALLATION

Anchor metal panels and other components of the Work securely in place, using manufacturer's approved fasteners according to manufacturers' written instructions.

## 3.7 FLASHING, TRIM AND CLOSURE INSTALLATION

a. Comply with performance requirements, manufacturer's written installation instructions, and SMACNA 1793. Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.

b. Sheet metalwork is to be accomplished to form weather-tight construction without waves, warps, buckles, fastening stresses or distortion, and allow for expansion and contraction. Cutting, fitting, drilling, and other operations in connection with sheet metal required to accommodate the work of other trades is to be performed by sheet metal mechanics.

## 3.8 DOOR AND FRAME INSTALLATION

Install doors and frames plumb, rigid, properly aligned, and securely fastened in place according to manufacturer's written instructions. Coordinate installation with metal panel flashings and other components. Caulk and seal perimeter of each door frame with elastomeric sealant compatible with metal panels. Comply with installation requirements in Division 08 - OPENINGS.

## 3.9 WINDOW INSTALLATION

Install windows plumb, rigid, properly aligned, without warp or rack of frames or sash, and securely fastened in place according to manufacturer's written instructions. Coordinate installation with metal panel flashings and other components. Caulk and seal perimeter of each window frame with elastomeric sealant compatible with for metal panels. Comply with installation requirements in Division 08 - OPENINGS.

## 3.10 ACCESSORY INSTALLATION

### 3.10.1 General

Install accessories with positive anchorage to building and weather-tight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.

### 3.10.2 Dissimilar Metals

Where dissimilar metals contact one another or corrosive substrates are present, protect against galvanic action by painting dissimilar metal surfaces with bituminous coating, by applying rubberized-asphalt underlayment to each surface, or by other permanent separation techniques as recommended by the metal building manufacturer.

### 3.10.3 Gutters and Downspouts

Comply with performance requirements, manufacturer's written installation instructions, and install sheet metal roof drainage items to produce complete roof drainage system according to SMACNA 1793 recommendations and as indicated. Coordinate installation of roof perimeter flashing with installation of roof drainage system.

### 3.10.4 Insulation

Comply with performance requirements and manufacturer's written installation instructions. Install insulation concurrently with metal panel installation, in thickness indicated to cover entire roof and wall area.

### 3.10.5 Roof and Wall Accessories and Specialties

Install roof and wall accessories and specialties complete with necessary hardware, anchors, dampers, weather guards, rain caps, and equipment supports.

## 3.11 CLEAN-UP AND PROTECTION

### 3.11.1 Structural Framing

Clean all exposed structural framing at completion of installation. Remove metal shavings, filings, bolts, and wires from work area. Remove grease and oil films, excess sealants, handling marks, contamination from steel wool, fittings and drilling debris and scrub the work clean. Exposed metal surfaces to be free of dents, creases, waves, scratch marks, solder or weld marks, and damage to the finish coating.

### 3.11.2 Metal Panels

Clean all exposed sheet metal work at completion of installation. Remove metal shavings, filings, nails, bolts, and wires from work area. Remove protective coverings/films, grease and oil films, excess sealants, handling marks, contamination from steel wool, fittings and drilling debris and scrub the work clean. Exposed metal surfaces to be free of dents, creases, waves, scratch marks, solder or weld marks, and damage to the finish coating.

### 3.11.3 Touch-Up Painting

After erection, promptly clean, prepare, and prime or re-prime field connections, rust spots, and abraded surfaces of prime-painted structural framing and accessories. Clean and touch-up paint with manufacturer's touch-up paint.

## 3.12 WARRANTY

### 3.12.1 MANUFACTURER'S STANDARD WARRANTY

Submit all manufacturers' signed warranties to Contracting Officer prior to final commissioning and acceptance.

### 3.12.2 CONTRACTOR'S STANDARD WARRANTY for INSTALLATION

Submit contractor's warranty for installation to the Contracting Officer prior to final commissioning and acceptance.

-- End of Section 13 34 19 --

SECTION 22 00 00
PLUMBING, GENERAL PURPOSE

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

| | |
|---|---|
| ASHRAE 90.1 - IP | (2013; INT 1 2013; Errata 1-2 2013) Energy Standard for Buildings Except Low-Rise Residential Buildings |

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

| | |
|---|---|
| ASSE 1018 | (2001) Performance Requirements for Trap Seal Primer Valves - Potable Water Supplied (ANSI Approved 2002 |

AMERICAN WATER WORKS ASSOCIATION (AWWA)

| | |
|---|---|
| AWWA C651 | (2005; Errata 2005) Standard for Disinfecting Water Mains |
| AWWA C652 | (2011) Disinfection of Water-Storage Facilities |

ASME INTERNATIONAL (ASME)

| | |
|---|---|
| ASME A112.19.2/CSA B45.1 | (2013) Standard for Vitreous China Plumbing Fixtures and Hydraulic Requirements for Water Closets and Urinals |
| ASME A112.6.1M | (1997; R 2012) Floor Affixed Supports for Off-the-Floor Plumbing Fixtures for Public Use |
| ASME A112.6.3 | (2001; R 2007) Standard for Floor and Trench Drains |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM C564 | (2012) Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings |

INTERNATIONAL ASSOCIATION OF PLUMBING AND MECHANICAL OFFICIALS (IAPMO)

| | |
|---|---|
| IAPMO Z124.1.2 | (2005) Plastic Bathtub and Shower Units |

INTERNATIONAL CODE COUNCIL (ICC)

| | |
|---|---|
| ICC IPC | (2012) International Plumbing Code |

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

| | |
|---|---|
| MSS SP-110 | (2010) Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends |

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

| | |
|---|---|
| EPA SM 9223 | (2004) Enzyme Substrate Coliform Test |

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

| | |
|---|---|
| 40 CFR 50.12 | National Primary and Secondary Ambient Air Quality Standards for Lead |
| PL 109-58 | Energy Policy Act of 2005 (EPAct05) |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 174 | (2004; Reprint Sep 2012) Household Electric Storage Tank Water Heaters |
| UL 499 | (2005; Reprint Feb 2013) Electric Heating Appliances |

1.2 SUBMITTALS

Contracting Officer's written approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Fixtures

List of installed fixtures with manufacturer, model, and flow rate.

SD-06 Test Reports

Tests, Flushing and Disinfection

Test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified

performance criteria, completion and testing of the installed system. Each test report shall indicate the final position of controls.

SD-07 Certificates

Materials

## 1.3 STANDARD PRODUCTS

Specified materials shall be standard products of a manufacturer regularly engaged in the manufacture of such products. Specified equipment shall essentially duplicate equipment that has performed satisfactorily at least two years prior to bid opening. Standard products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year use shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2 year period.

### 1.3.1 Service Support

The equipment items shall be supported by service organizations. Submit a certified list of qualified permanent service organizations for support of the equipment which includes their addresses and qualifications. These service organizations shall be reasonably convenient to the equipment installation and able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

### 1.3.2 Modification of References

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction", or words of similar meaning, to mean the Contracting Officer.

#### 1.3.2.1 Definitions

For the International Code Council (ICC) Codes referenced in the contract documents, advisory provisions shall be considered mandatory, the word "should" shall be interpreted as "shall." Reference to the "code official" shall be interpreted to mean the "Contracting Officer." For USCG owned property, references to the "owner" shall be interpreted to mean the "Contracting Officer." For leased facilities, references to the "owner" shall be interpreted to mean the "lessor." References to the "permit holder" shall be interpreted to mean the "Contractor."

#### 1.3.2.2 Administrative Interpretations

For ICC Codes referenced in the contract documents, the provisions of Chapter 1, "Administrator," do not apply. These administrative requirements are covered by the applicable Federal Acquisition Regulations (FAR) included in this contract and by the authority granted to

the Contracting Officer's Representative to administer the construction of this project. References in the ICC Codes to sections of Chapter 1, shall be applied appropriately by the Contracting Officer as authorized by his administrative cognizance and the FAR.

## 1.4 DELIVERY, STORAGE, AND HANDLING

Handle, store, and protect equipment and materials to prevent damage before and during installation in accordance with the manufacturer's recommendations, and as approved by the Contracting Officer's Representative. Replace damaged or defective items.

## 1.5 REGULATORY REQUIREMENTS

Unless otherwise required herein, plumbing work shall be in accordance with ICC IPC. Energy consuming products and systems shall be in accordance with PL 109-58 and ASHRAE 90.1 – IP.

## 1.6 PROJECT/SITE CONDITIONS

The Contractor shall become familiar with details of the work, verify dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

## 1.7 ACCESSIBILITY OF EQUIPMENT

Install all work so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible. Install concealed valves, expansion joints, controls, dampers, and equipment requiring access, in locations freely accessible through access doors.

# PART 2 PRODUCTS

## 2.1 VALVES

Valves shall be provided on supplies to equipment and fixtures. Valves 2-1/2 inches and smaller shall be bronze with threaded bodies for pipe and solder-type connections for tubing. Valves 3 inches and larger shall have flanged iron bodies and bronze trim. Pressure ratings shall be based upon the application. Grooved end valves may be provided if the manufacturer certifies that the valves meet the performance requirements of applicable MSS standard. Valves shall conform to the following standards:

| Description | Standard |
|---|---|
| Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends | MSS SP-110 |

### 2.1.1 Thermostatic Mixing Valves

Provide thermostatic mixing valve for lavatory faucets. Mixing valves, thermostatic type, pressure-balanced or combination thermostatic and pressure-balanced shall be line size and shall

be constructed with rough or finish bodies either with or without plating. Each valve shall be constructed to control the mixing of hot and cold water and to deliver water at a desired temperature regardless of pressure or input temperature changes. The control element shall be of an approved type. The body shall be of heavy cast bronze, and interior parts shall be brass, bronze, corrosion-resisting steel or copper. The valve shall be equipped with necessary stops, check valves, unions, and sediment strainers on the inlets. Mixing valves shall maintain water temperature within 5 degrees F of any setting.

## 2.2 FIXTURES

Existing Fixtures shall be equipped with appurtenances such as traps, faucets, stop valves, and drain fittings. Each fixture and piece of equipment requiring connections to the drainage system, except grease interceptors, shall be equipped with a trap. Brass expansion or toggle bolts capped with acorn nuts shall be provided for supports, and polished chromium-plated pipe, valves, and fittings shall be provided where exposed to view. Internal parts of flush and/or flushometer valves, shower mixing valves, shower head face plates, shall be copper alloy with all visible surfaces chrome plated.

### 2.2.1 Flush Valve Water Closets

Provide large diameter flush valve including angle control-stop valve, vacuum breaker, tail pieces, slip nuts, and wall plates; exposed to view components shall be chromium-plated or polished stainless steel. Flush valves shall be nonhold-open type. Mount flush valves not less than 11 inches above the fixture.

### 2.2.2 Flush Valve Urinals

ASME A112.19.2/CSA B45.1, white vitreous china, wall-mounted, wall outlet, siphon jet, integral trap, and extended side shields. Provide urinal with the rim 17 inches above the floor. Water flushing volume of the urinal and flush valve combination shall not exceed 0.5 gallons per flush. Provide ASME A112.6.1M concealed chair carriers with vertical steel pipe supports. Provide large diameter flush valve including angle control-stop valve, vacuum breaker, tail pieces, slip nuts, and wall plates; exposed to view components shall be chromium-plated or polished stainless steel. Flush valves shall be nonhold-open type. Mount flush valves not less than 11 inches above the fixture.

### 2.2.3 Wall Hung Lavatory Faucets

Water flow rate shall not exceed 1.0 gpm when measured at a flowing water pressure of 60 psi. Provide top mounted washerless centerset lavatory faucets.

### 2.2.4 Plastic Shower Stalls

IAPMO Z124.1.2 four piece white solid acrylic pressure molded fiberglass reinforced plastic shower stalls. Shower stalls shall be scratch resistant, waterproof, and reinforced. Showerhead water flow rate shall not exceed 1.5 gpm when measured at a flowing water pressure of 80 psi.

Provide recessed type shower stalls approximately 36 inches wide, 36 inches front to rear, 76 inches high, and 5 inch high curb with shower stall bottom or feet firmly supported by a smooth level floor. Provide PVC shower floor drains and stainless steel strainers. Shower stalls shall meet performance requirements of IAPMO Z124.1.2 and shall be labeled by NAHB Research Foundation, Inc. for compliance. Install shower stall in accordance with the manufacturer's written instructions. Finish installation by covering shower stall attachment flanges with dry-wall in accordance with shower stall manufacturer's recommendation. Provide smooth 100 percent silicone rubber white bathtub calk between the top, sides, and bottom of shower stalls and bathroom walls and floors.

## 2.3 DRAINS

### 2.3.1 Floor and Shower Drains

Floor and shower drains shall consist of a galvanized body, integral seepage pan, and adjustable perforated or slotted chromium-plated bronze, nickel-bronze, or nickel-brass strainer, consisting of grate and threaded collar. Floor drains shall be cast iron except where metallic waterproofing membrane is installed. Drains shall be of double drainage pattern for embedding in the floor construction. The seepage pan shall have weep holes or channels for drainage to the drainpipe. The strainer shall be adjustable to floor thickness. A clamping device for attaching flashing or waterproofing membrane to the seepage pan without damaging the flashing or waterproofing membrane shall be provided when required. Drains shall be provided with threaded connection. Between the drain outlet and waste pipe, a neoprene rubber gasket conforming to ASTM C564 may be installed, provided that the drain is specifically designed for the rubber gasket compression type joint. Floor and shower drains shall conform to ASME A112.6.3. Provide drain with trap primer connection, trap primer, and connection piping. Primer shall meet ASSE 1018.

#### 2.3.1.1 Drains

Drains installed in connection with waterproofed floors or shower pans shall be equipped with bolted-type device to securely clamp flashing.

## 2.4 WATER HEATERS

Water heater types and capacities shall be as indicated. Each water heater shall have replaceable anodes. Each primary water heater shall have controls with an adjustable range that includes 90 to 160 degrees F. Hot water systems utilizing recirculation systems shall be tied into building off-hour controls. The thermal efficiencies and standby heat losses shall conform to TABLE III for each type of water heater specified. Plastic materials polyetherimide (PEI) and polyethersulfone (PES) are forbidden to be used for vent piping of combustion gases. A factory pre-charged expansion tank shall be installed on the cold water supply to each water heater. Expansion tanks shall be specifically designed for use on potable water systems and shall be rated for 200 degrees F water temperature and 150 psi working pressure. The expansion tank size and acceptance volume shall be as indicated.

2.4.1 Automatic Storage Type

Heaters shall be complete with control system, temperature gauge, and pressure gauge, and shall have ASME rated combination pressure and temperature relief valve.

2.4.1.1 Electric Type

Electric type water heaters shall conform to UL 174 with dual heating elements if indicated on plans. The elements shall be wired so that only one element can operate at a time.

2.4.2 Electric Instantaneous Water Heaters (Tankless)

UL 499 and UL listed flow switch activated, tankless electric instantaneous water heater for wall mounting below sink or lavatory.

2.5 MISCELLANEOUS PIPING ITEMS

2.5.1 Escutcheon Plates

Provide one piece or split hinge metal plates for piping entering floors, walls, and ceilings in exposed spaces. Provide chromium-plated on copper alloy plates or polished stainless steel finish in finished spaces. Provide paint finish on plates in unfinished spaces.

PART 3 EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

The plumbing system shall be installed complete with necessary fittings, traps, valves, and accessories.

3.1.1 Dissimilar Pipe Materials

Connections between ferrous and non-ferrous copper water pipe shall be made with dielectric unions or flange waterways. Dielectric waterways shall have temperature and pressure rating equal to or greater than that specified for the connecting piping. Waterways shall have metal connections on both ends suited to match connecting piping. Dielectric waterways shall be internally lined with an insulator specifically designed to prevent current flow between dissimilar metals. Dielectric flanges shall meet the performance requirements described herein for dielectric waterways. Connecting joints between plastic and metallic pipe shall be made with transition fitting for the specific purpose.

3.2 WATER HEATERS

3.2.1 Relief Valves

No valves shall be installed between a relief valve and its water heater or storage tank. The P&T relief valve shall be installed where the valve actuator comes in contact with the hottest water in the heater. Whenever possible, the relief valve shall be installed directly in a tapping in the tank or heater; otherwise, the P&T valve shall be installed in the hot-water outlet piping. A vacuum relief valve shall be provided on the cold water supply line to the hot-water storage tank or water heater and mounted above and within 6 inches above the top of the tank or water heater.

3.2.2 Heat Traps

Piping to and from each water heater and hot water storage tank shall be routed horizontally and downward a minimum of 2 feet before turning in an upward direction.

3.2.3 Connections to Water Heaters

Connections of metallic pipe to water heaters shall be made with dielectric unions or flanges.

3.2.4 Expansion Tank

A pre-charged expansion tank shall be installed on the cold water supply between the water heater inlet and the cold water supply shut-off valve. The Contractor shall adjust the expansion tank air pressure, as recommended by the tank manufacturer, to match incoming water pressure.

3.3 FIXTURE TRIMMINGS

Polished chromium-plated pipe, valves, and fittings shall be provided where exposed to view. Angle stops, straight stops, stops integral with the faucets, or concealed type of lock-shield, and loose-key pattern stops for supplies with threaded, sweat or solvent weld inlets shall be furnished and installed with fixtures. Where connections between copper tubing and faucets are made by rubber compression fittings, a beading tool shall be used to mechanically deform the tubing above the compression fitting. Exposed traps and supply pipes for fixtures and equipment shall be connected to the rough piping systems at the wall, unless otherwise specified under the item. Floor and wall escutcheons shall be as specified. Drain lines and hot water lines of fixtures for handicapped personnel shall be insulated and do not require polished chrome finish. Plumbing fixtures and accessories shall be installed within the space shown.

3.3.1 Shower Outfits

The area around the water supply piping to the mixing valves and behind the escutcheon plate shall be made watertight by caulking or gasketing.

3.4 ESCUTCHEONS

Escutcheons shall be provided at finished surfaces where bare or insulated piping, exposed to view, passes through floors, walls, or ceilings, except in boiler, utility, or equipment rooms. Escutcheons shall be fastened securely to pipe or pipe covering and shall be satin-finish, corrosion-resisting steel, polished chromium-plated zinc alloy, or polished chromium-plated

copper alloy. Escutcheons shall be either one-piece or split-pattern, held in place by internal spring tension or setscrew.

## 3.5 TESTS, FLUSHING AND DISINFECTION

### 3.5.1 Plumbing System

The following tests shall be performed on the plumbing system in accordance with ICC IPC.

### 3.5.2 Defective Work

If inspection or test shows defects, such defective work or material shall be replaced or repaired as necessary and inspection and tests shall be repeated. Repairs to piping shall be made with new materials. Caulking of screwed joints or holes will not be acceptable.

### 3.5.3 System Flushing

#### 3.5.3.1 During Flushing

Before operational tests or disinfection, potable water piping system shall be flushed with hot potable water. Sufficient water shall be used to produce a water velocity that is capable of entraining and removing debris in all portions of the piping system. This requires simultaneous operation of all fixtures on a common branch or main in order to produce a flushing velocity of approximately 4 fps through all portions of the piping system. In the event that this is impossible due to size of system, the Contracting Officer's Representative (or the designated representative) shall specify the number of fixtures to be operated during flushing. Contractor shall provide adequate personnel to monitor the flushing operation and to ensure that drain lines are unobstructed in order to prevent flooding of the facility. Contractor shall be responsible for any flood damage resulting from flushing of the system. Flushing shall be continued until entrained dirt and other foreign materials have been removed and until discharge water shows no discoloration. All faucets and drinking water fountains, to include any device considered as an end point device by NSF 61, Section 9, shall be flushed a minimum of 0.25 gallons per 24 hour period, ten times over a 14 day period.

#### 3.5.3.2 After Flushing

System shall be drained at low points. Strainer screens shall be removed, cleaned, and replaced. After flushing and cleaning, systems shall be prepared for testing by immediately filling water piping with clean, fresh potable water. Any stoppage, discoloration, or other damage to the finish, furnishings, or parts of the building due to the Contractor's failure to properly clean the piping system shall be repaired by the Contractor. When the system flushing is complete, the hot-water system shall be adjusted for uniform circulation. Flushing devices and automatic control systems shall be adjusted for proper operation according to manufacturer's instructions. Comply with ASHRAE 90.1 - IP for minimum efficiency requirements. Unless more stringent local requirements exist, lead levels shall not exceed limits established by 40 CFR 50.12 Part 141.80(c)(1). The water supply to the building shall be tested separately to ensure that any lead

contamination found during potable water system testing is due to work being performed inside the building.

3.5.4 Disinfection

A. After all system components are provided and operational tests are complete, the entire domestic hot- and cold-water distribution system shall be disinfected. Before introducing disinfecting chlorination material, entire system shall be flushed with potable water until any entrained dirt and other foreign materials have been removed.

1. Water chlorination procedure shall be in accordance with AWWA C651 and AWWA C652 as modified and supplemented by this specification. The chlorinating material shall be hypochlorites or liquid chlorine. The chlorinating material shall be fed into the water piping system at a constant rate at a concentration of at least 50 parts per million (ppm). Feed a properly adjusted hypochlorite solution injected into the system with a hypochlorinator, or inject liquid chlorine into the system through a solution-feed chlorinator and booster pump until the entire system is completely filled.

2. Test the chlorine residual level in the water at 6 hour intervals for a continuous period of 24 hours. If at the end of a 6 hour interval, the chlorine residual has dropped to less than 25 ppm, flush the piping including tanks with potable water, and repeat the above chlorination procedures. During the chlorination period, each valve and faucet shall be opened and closed several times.

3. After the second 24 hour period, verify that no less than 25 ppm chlorine residual remains in the treated system. The 24 hour chlorination procedure must be repeated until no less than 25 ppm chlorine residual remains in the treated system.

4. Upon the specified verification, the system including tanks shall then be flushed with potable water until the residual chlorine level is reduced to less than one part per million. During the flushing period, each valve and faucet shall be opened and closed several times.

5. Take addition samples of water in disinfected containers, for bacterial examination, at locations specified by the Contracting Officer's Representative. Test these samples for total coliform organisms (coliform bacteria, fecal coliform, streptococcal, and other bacteria) in accordance with EPA SM 9223. The testing method used shall be EPA approved for drinking water systems and shall comply with applicable local and state requirements.

6. Disinfection shall be repeated until bacterial tests indicate the absence of coliform organisms (zero mean coliform density per 100 milliliters) in the samples for at least 2 full days. The system will not be accepted until satisfactory bacteriological results have been obtained.

-- End of Section 22 00 00 --

SECTION 23 00 00
AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEMS

PART 1 GENERAL

1.1 REFERENCES

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

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL (AMCA)

| | |
|---|---|
| AMCA 300 | (2008) Reverberant Room Method for Sound Testing of Fans |
| AMCA 301 | (2006; INT 2007; Errata 2008) Methods for Calculating Fan Sound Ratings from Laboratory Test Data |

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

| | |
|---|---|
| AHRI Guideline D | (1996) Application and Installation of Central Station Air-Handling Units |

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

| | |
|---|---|
| ASHRAE 70 | (2006; r 2011) Method of Testing for Rating the Performance of Air Outlets and Inlets |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| NEMA MG 1 | (2011; Errata 2012) Motors and Generators |
| NEMA MG 10 | (2001; R 2007) Energy Management Guide for Selection and Use of Fixed Frequency Medium AC Squirrel-Cage Polyphase Induction Motors |
| NEMA MG 11 | (1977; R 2007) Energy Management Guide for Selection and Use of Single Phase Motors |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 701 | (2010) Standard Methods of Fire Tests for Flame Propagation of Textiles and Films |

| | |
|---|---|
| NFPA 90A | (2012) Standard for the Installation of Air Conditioning and Ventilating Systems |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 6 | (2007; reprint Nov 2010) Electrical Rigid Metal Conduit-Steel |
| UL 705 | (2004; Reprint Oct 2009) Standard for Power Ventilators |
| UL Bld Mat Dir | (2012) Building Materials Directory |

1.2 SYSTEM DESCRIPTION

Furnish ductwork, piping offsets, fittings, and accessories as required to provide a complete installation. Coordinate the work of the different trades to avoid interference between piping, equipment, structural, and electrical work. Provide complete, in place, all necessary offsets in piping and ductwork, and all fittings, and other components, required to install the work as indicated and specified.

1.3 SUBMITTALS

Contracting Officer's written approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

a. Duct Connectors

b. Diffusers

c. Registers and Grilles

d. In-Line Centrifugal Fans

e. Centrifugal Type Power Roof Ventilators

1.4 QUALITY ASSURANCE

Except as otherwise specified, approval of materials and equipment is based on manufacturer's published data.

a. Where materials and equipment are specified to conform to the standards of the Underwriters Laboratories, the label of or listing with reexamination in UL Bld Mat Dir, and UL 6 is acceptable as sufficient evidence that the items conform to Underwriters Laboratories requirements. In lieu of such label or listing, submit a written certificate from any

nationally recognized testing agency, adequately equipped and competent to perform such services, stating that the items have been tested and that the units conform to the specified requirements. Outline methods of testing used by the specified agencies.

b. Where materials or equipment are specified to be constructed or tested, or both, in accordance with the standards of the ASTM International (ASTM), the ASME International (ASME), or other standards, a manufacturer's certificate of compliance of each item is acceptable as proof of compliance.

c. Conformance to such agency requirements does not relieve the item from compliance with other requirements of these specifications.

1.4.1 Asbestos Prohibition

Do not use asbestos and asbestos-containing products.

1.5 DELIVERY, STORAGE, AND HANDLING

Protect stored equipment at the jobsite from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Additionally, cap or plug all pipes until installed.

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS

Except for the fabricated duct, plenums and casings specified in paragraphs "Metal Ductwork" and "Plenums and Casings for Field-Fabricated Units", provide components and equipment that are standard products of manufacturers regularly engaged in the manufacturing of products that are of a similar material, design and workmanship. This requirement applies to all equipment, including diffusers, registers, fire dampers, and balancing dampers.

a. Standard products are defined as components and equipment that have been in satisfactory commercial or industrial use in similar applications of similar size for at least two years before bid opening.

b. Prior to this two year period, these standard products shall have been sold on the commercial market using advertisements in manufacturers' catalogs or brochures. These manufacturers' catalogs, or brochures shall have been copyrighted documents or have been identified with a manufacturer's document number.

2.2 EQUIPMENT GUARDS AND ACCESS

Fully enclose or guard belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts exposed to personnel contact according to OSHA requirements. Properly guard or cover with insulation of a type specified, high temperature equipment and piping exposed to contact by personnel or where it creates a potential fire hazard.

## 2.3 ELECTRICAL WORK

a. Provide motors, controllers, integral disconnects, contactors, and controls with their respective pieces of equipment, except controllers indicated as part of motor control centers. Provide electrical equipment, including motors and wiring. Provide manual or automatic control and protective or signal devices required for the operation specified and control wiring required for controls and devices specified, but not shown. For packaged equipment, include manufacturer provided controllers with the required monitors and timed restart.

b. For single-phase motors, provide high-efficiency type, fractional-horsepower alternating-current motors, including motors that are part of a system, in accordance with NEMA MG 11. Integral size motors shall be the premium efficiency type in accordance with NEMA MG 1.

c. For polyphase motors, provide squirrel-cage medium induction motors, including motors that are part of a system , and that meet the efficiency ratings for premium efficiency motors in accordance with NEMA MG 1. Select premium efficiency polyphase motors in accordance with NEMA MG 10.

d. Provide motors in accordance with NEMA MG 1 and of sufficient size to drive the load at the specified capacity without exceeding the nameplate rating of the motor. Provide motors rated for continuous duty with the enclosure specified. Provide motor duty that allows for maximum frequency start-stop operation and minimum encountered interval between start and stop. Provide motor torque capable of accelerating the connected load within 20 seconds with 80 percent of the rated voltage maintained at motor terminals during one starting period. Provide motor starters complete with thermal overload protection and other necessary appurtenances. Fit motor bearings with grease supply fittings and grease relief to outside of the enclosure.

## 2.4 DUCT SYSTEMS

### 2.4.1 General Service Duct Connectors

Provide a flexible duct connector approximately 6 inches in width ductboard connections are made to fans. For rectangular ducts, install the flexible material locked to metal collars using normal duct construction methods. Provide a composite connector system that complies with NFPA 701 and is classified as "flame-retarded fabrics" in UL Bld Mat Dir.

### 2.4.2 Diffusers, Registers, and Grilles

Provide factory-fabricated units of plastic material (no ferrous or aluminum) that distribute the specified quantity of air evenly over space intended without causing noticeable drafts, air movement faster than 50 fpm in occupied zone, or dead spots anywhere in the conditioned area. Provide outlets for diffusion, spread, throw, and noise level as required for specified performance. Certify performance according to ASHRAE 70. Provide sound rated and certified

inlets and outlets according to ASHRAE 70. Provide sound power level as indicated. Provide diffusers and registers with volume damper with accessible operator, unless otherwise indicated; or if standard with the manufacturer, an automatically controlled device is acceptable. Provide opposed blade type volume dampers for all diffusers and registers. Where the inlet and outlet openings are located less than 7 feet above the floor, protect them by a grille or screen according to NFPA 90A. All volume dampers shall be opposed blade type constructed of a material other than aluminum or ferrous materials.

2.4.2.1 Diffusers

Provide diffuser types indicated. Furnish ceiling mounted units with anti-smudge devices, unless the diffuser unit minimizes ceiling smudging through design features. Provide diffusers with air deflectors of the type indicated. Install ceiling mounted units with rims tight against ceiling. Provide sponge rubber gaskets between ceiling and surface mounted diffusers for air leakage control. Provide suitable trim for flush mounted diffusers. For connecting the duct to diffuser, provide duct collar that is airtight and does not interfere with volume controller. Provide return or exhaust units that are similar to supply diffusers.

2.4.2.2 Perforated Plate Diffusers

Provide adjustable one-way, two-way, three-way, or four-way air pattern controls as indicated. Provide diffuser faceplates that do not sag or deflect when operating under design conditions.

2.4.2.3 Registers and Grilles

Provide units that are four-way directional-control type, except provide return and exhaust registers that are fixed horizontal or vertical louver type similar in appearance to the supply register face. Furnish registers with sponge-rubber gasket between flanges and wall or ceiling. Install wall supply registers at least 6 inches below the ceiling unless otherwise indicated. Locate return and exhaust registers 6 inches above the floor unless otherwise indicated. Achieve four-way directional control by a grille face which can be rotated in 4 positions or by adjustment of horizontal and vertical vanes. Provide grilles as specified for registers, without volume control damper.

2.4.2.4 Registers

Double-deflection supply registers. Provide manufacturer-furnished volume dampers. Provide volume dampers of the group-operated, opposed-blade type and key adjustable by inserting key through face of register. Operating mechanism shall not project through any part of the register face. Automatic volume control devices are acceptable. Provide exhaust and return registers as specified for supply registers, except provide exhaust and return registers that have a single set of nondirectional face bars or vanes having the same appearance as the supply registers.

2.5 AIR SYSTEMS EQUIPMENT

### 2.5.1 Fans

The sound power level of the fans shall not exceed 85 dBA when tested according to AMCA 300 and rated in accordance with AMCA 301. Provide all fans with an AMCA seal. Connect fans to the motors either directly or indirectly with V-belt drive. Use V-belt drives designed for not less than 150 percent of the connected driving capacity. Provide variable pitch motor sheaves for 15 hp and below, and fixed pitch as defined by AHRI Guideline D. Select variable pitch sheaves to drive the fan at a speed which can produce the specified capacity when set at the approximate midpoint of the sheave adjustment. When fixed pitch sheaves are furnished, provide a replaceable sheave when needed to achieve system air balance. Provide motors for V-belt drives with adjustable rails or bases. Provide removable metal guards for all exposed V-belt drives, and provide speed-test openings at the center of all rotating shafts. Provide fans with personnel screens or guards on both suction and supply ends, except that the screens need not be provided, unless otherwise indicated, where ducts are connected to the fan. Provide fan and motor assemblies with vibration-isolation supports or mountings as indicated. Use vibration-isolation units that are standard products with published loading ratings. Select each fan to produce the capacity required at the fan static pressure indicated. Provide sound power level as indicated. Obtain the sound power level values according to AMCA 300. Provide standard AMCA arrangement, rotation, and discharge as indicated. Provide power ventilators that conform to UL 705 and have a UL label.

#### 2.5.1.1 Centrifugal Type Power Roof Ventilators

Provide V-belt driven centrifugal type fans with backward inclined, non-overloading wheel. Provide hinged or removable and weatherproof motor compartment housing, constructed of heavy gauge aluminum. Provide fans with birdscreen, disconnect switch, gravity dampers, roof curb, and extended base. Provide dripproof type motor enclosure. Provide centrifugal type kitchen exhaust fans according to UL 705, fitted with V-belt drive, round hood, and windband upblast discharge configuration, integral residue trough and collection device, with motor and power transmission components located in outside positively air ventilated compartment. Use only lubricated bearings.

#### 2.5.1.2 In-Line Centrifugal Fans

Provide in-line fans with centrifugal backward inclined blades, stationary discharge conversion vanes, internal and external belt guards, and adjustable motor mounts. Mount fans in a welded tubular casing. Provide a fan that axially flows the air in and out. Streamline inlets with conversion vanes to eliminate turbulence and provide smooth discharge air flow. Enclose and isolate fan bearings and drive shafts from the air stream. Provide precision, self aligning ball or roller type fan bearings that are sealed against dust and dirt and are permanently lubricated. Provide L50 rated bearing life at not less than 200,000 hours as defined by ABMA 9 and ABMA 11. Provide motors with open or totally enclosed enclosure. Provide magnetic motor starters across-the-line with general-purpose enclosures.

## PART 3 EXECUTION

## 3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer and Contracting Officer's Representative of any discrepancy before performing the work.

## 3.2 INSTALLATION

a. Install materials and equipment in accordance with the requirements of the contract drawings and approved manufacturer's installation instructions. Accomplish installation by workers skilled in this type of work. Perform installation so that there is no degradation of the designed fire ratings of walls, partitions, ceilings, and floors.

b. No installation is permitted to block or otherwise impede access to any existing machine or system. Install all hinged doors to swing open a minimum of 120 degrees. Provide an area in front of all access doors that clears a minimum of 3 feet. In front of all access doors to electrical circuits, clear the area the minimum distance to energized circuits as specified in OSHA Standards, part 1910.333 (Electrical-Safety Related work practices)and an additional 3 feet.

c. Except as otherwise indicated, install emergency switches and alarms in conspicuous locations. Mount all indicators, to include gauges, meters, and alarms in order to be easily visible by people in the area.

### 3.2.1 Access Panels

Install access panels for concealed valves, vents, controls, dampers, and items requiring inspection or maintenance of sufficient size, and locate them so that the concealed items are easily serviced and maintained or completely removed and replaced.

### 3.2.2 Metal Ductwork

Install according to SMACNA unless otherwise indicated. Install duct supports for fiberglass ductwork according to SMACNA, unless otherwise specified. Do not use friction beam clamps indicated in SMACNA. Anchor risers on high velocity ducts in the center of the vertical run to allow ends of riser to move due to thermal expansion. Erect supports on the risers that allow free vertical movement of the duct. Attach supports only to structural framing members and concrete slabs. Do not anchor supports to metal decking unless a means is provided and approved for preventing the anchor from puncturing the metal decking. Where supports are required between structural framing members, provide suitable intermediate framing. Where C-clamps are used, provide retainer clips.

### 3.2.3 Power Roof Ventilator Mounting

Provide foamed 1/2 inch thick, closed-cell, flexible elastomer insulation to cover width of roof curb mounting flange. Where wood nailers are used, predrill holes for fasteners.

### 3.2.4 Power Transmission Components Adjustment

Test V-belts and sheaves for proper alignment and tension prior to operation and after 72 hours of operation at final speed. Uniformly load belts on drive side to prevent bouncing. Make alignment of direct driven couplings to within 50 percent of manufacturer's maximum allowable range of misalignment.

## 3.3 CUTTING AND PATCHING

Install work in such a manner and at such time that a minimum of cutting and patching of the building structure is required. Make holes in exposed locations, in or through existing floors, by drilling and smooth by sanding. Use of a jackhammer is permitted only where specifically approved. Make holes through masonry walls to accommodate sleeves with an iron pipe masonry core saw.

## 3.4 CLEANING

Thoroughly clean surfaces of piping and equipment that have become covered with dirt, plaster, or other material during handling and construction before such surfaces are prepared for final finish painting or are enclosed within the building structure. Before final acceptance, clean mechanical equipment, including piping, ducting, and fixtures, and free from dirt, grease, and finger marks. When the work area is in an occupied space such as office, laboratory or warehouse, protect all furniture and equipment from dirt and debris. Incorporate housekeeping for field construction work which leaves all furniture and equipment in the affected area free of construction generated dust and debris; and, all floor surfaces vacuum-swept clean.

## 3.5 OPERATION AND MAINTENANCE

### 3.5.1 Operation And Maintenance Training

Conduct a training course for the members of the operating staff as designated by the Contracting Officer's Representative. Make the training period consist of a total of 2 hours of normal working time and start it after all work specified herein is functionally completed and the Performance Tests have been approved. Conduct field instruction that covers all of the items contained in the Operation and Maintenance Manuals as well as demonstrations of routine maintenance operations. Submit the proposed On-site Training schedule concurrently with the Operation and Maintenance Manuals and at least 14 days prior to conducting the training course.

-- End of Section 23 00 00 --

SECTION 23 03 00
BASIC MECHANICAL MATERIALS AND METHODS

PART 1 GENERAL

1.1 REFERENCES

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

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM B 117 | (2009) Standing Practice for Operating Salt Spray (Fog) Apparatus |

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

| | |
|---|---|
| IEEE C2 | (2012; Errata 2012; INT 1-4 2012; INT 5-7 2013) National Electrical Safety Code |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| NEMA MG 11 | (1977; R 2007) Energy Management Guide for Selection and Use of Single Phase Motors |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 70 | (2014; AMD 1 2013; Errata 1 2013; AMD 2 2013; Errata 2 2013; AMD 3 2014; Errata 3 2014) National Electrical Code |

1.2 SUBMITTALS

Contracting Officer's written approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-07 Certificates

Alternative Qualifications

Service Support

1.3 RELATED REQUIREMENTS

This section applies to all sections of Divisions: 23, HEATING, VENTILATING, AND AIR CONDITIONING of this project specification, unless specified otherwise in the individual section.

## 1.4 QUALITY ASSURANCE

### 1.4.1 Material and Equipment Qualifications

Provide materials and equipment that are standard products of manufacturers regularly engaged in the manufacture of such products, which are of a similar material, design and workmanship. Standard products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year use shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2 year period.

### 1.4.2 Alternative Qualifications

Products having less than a two-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturer's factory or laboratory tests, can be shown. Submit alternative qualifications to the Contracting Officer for approval.

### 1.4.3 Service Support

The equipment items shall be supported by service organizations. Submit a certified list of qualified permanent service organizations for support of the equipment which includes their addresses and qualifications to the Contracting Officer. These service organizations shall be reasonably convenient to the equipment installation and able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

### 1.4.4 Manufacturer's Nameplate

Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

### 1.4.5 Modification of References

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction", or words of similar meaning, to mean the Contracting Officer.

#### 1.4.5.1 Definitions

For the International Code Council (ICC) Codes referenced in the contract documents, advisory provisions shall be considered mandatory, the word "should" shall be interpreted as "shall." Reference to the "code official" shall be interpreted to mean the "Contracting Officer." For leased facilities, references to the "owner" shall be interpreted to mean the "lessor." References to the "permit holder" shall be interpreted to mean the "Contractor."

1.4.5.2 Administrative Interpretations

For ICC Codes referenced in the contract documents, the provisions of Chapter 1, "Administrator," do not apply. These administrative requirements are covered by the applicable Federal Acquisition Regulations (FAR) included in this contract and by the authority granted to the Contracting Officer to administer the construction of this project. References in the ICC Codes to sections of Chapter 1, shall be applied appropriately by the Contracting Officer as authorized by his administrative cognizance and the FAR.

## 1.5 DELIVERY, STORAGE, AND HANDLING

Handle, store, and protect equipment and materials to prevent damage before and during installation in accordance with the manufacturer's recommendations, and as approved by the Contracting Officer's Representative. Replace damaged or defective items.

## 1.6 ELECTRICAL REQUIREMENTS

Furnish motors, controllers, disconnects and contactors with their respective pieces of equipment. Furnish internal wiring for components of packaged equipment as an integral part of the equipment. Extended voltage range motors will not be permitted. Controllers and contactors shall have a maximum of 120 volt control circuits, and shall have auxiliary contacts for use with the controls furnished. When motors and equipment furnished are larger than sizes indicated, the cost of additional electrical service and related work shall be included under the section that specified that motor or equipment.

## 1.7 ELECTRICAL INSTALLATION REQUIREMENTS

Electrical installations shall conform to IEEE C2, NFPA 70, and requirements specified herein.

### 1.7.1 New Work

Provide electrical components of mechanical equipment, such as motors, motor starters (except starters/controllers which are indicated as part of a motor control center), control or push-button stations, float or pressure switches, solenoid valves, integral disconnects, and other devices functioning to control mechanical equipment, as well as control wiring and conduit for circuits rated 100 volts or less, to conform with the requirements of the section covering the mechanical equipment. Extended voltage range motors shall not be permitted. The interconnecting power wiring and conduit, control wiring rated 120 volts (nominal) and conduit, the motor control equipment forming a part of motor control centers, and the electrical power circuits shall be provided under Division 26, except internal wiring for components of package equipment shall

be provided as an integral part of the equipment. When motors and equipment furnished are larger than sizes indicated, provide any required changes to the electrical service as may be necessary and related work as a part of the work for the section specifying that motor or equipment.

1.7.2 Modifications to Existing Systems

Where existing mechanical systems and motor-operated equipment require modifications, provide electrical components under Division 26.

1.7.3 High Efficiency Motors

1.7.3.1 High Efficiency Single-Phase Motors

Unless otherwise specified, single-phase fractional-horsepower alternating-current motors shall be high efficiency types corresponding to the applications listed in NEMA MG 11.

1.8 ACCESSIBILITY

Install all work so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible. Install concealed valves, expansion joints, controls, dampers, and equipment requiring access, in locations freely accessible through access doors.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 PAINTING OF NEW EQUIPMENT

3.1.1 Factory Painting Systems

A. Manufacturer's standard factory painting systems may be provided subject to certification that the factory painting system applied will withstand 125 hours in a salt-spray fog test, except that equipment located outdoors shall withstand 500 hours in a salt-spray fog test. Salt-spray fog test shall be in accordance with ASTM B 117, and for that test the acceptance criteria shall be as follows: immediately after completion of the test, the paint shall show no signs of blistering, wrinkling, or cracking, and no loss of adhesion; and the specimen shall show no signs of rust creepage beyond 0.125 inch on either side of the scratch mark.

B. The film thickness of the factory painting system applied on the equipment shall not be less than the film thickness used on the test specimen. If manufacturer's standard factory painting system is being proposed for use on surfaces subject to temperatures above 120 degrees F, the factory painting system shall be designed for the temperature service.

-- End of Section 23 03 00 --

SECTION 23 05 93
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.1 REFERENCES

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

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL (AMCA)

| | |
|---|---|
| AMCA 203 | (1990) Field Performance Measurements of Fan Systems |

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

| | |
|---|---|
| ASHRAE 62.1 | (2010) Ventilation for Acceptable Indoor Air Quality |

ASSOCIATED AIR BALANCE COUNCIL (AABC)

| | |
|---|---|
| AABC MN-1 | (2002; 6th ed) National Standards for Total System Balance |
| AABC MN-4 | (1996) Test and Balance Procedures |

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

| | |
|---|---|
| RCBEA GUIDE | (2004) NASA Reliability Centered Building and Equipment Acceptance Guide |

NATIONAL ENVIRONMENTAL BALANCING BUREAU (NEBB)

| | |
|---|---|
| NEBB MASV | (2006) Procedural Standards for Measurements of Sound and Vibration; 2nd Edition |
| NEBB PROCEDURAL STANDARDS | (2005) Procedural Standards for Testing, Adjusting and Balancing (TAB) of Environmental Systems |

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

| | |
|---|---|
| SMACNA 1143 | (1985) HVAC Air Duct Leakage Test Manual, 1st Edition |
| SMACNA 1780 | (2002) HVAC Systems - Testing, Adjusting and Balancing, 3rd Edition |

SMACNA 1858 (2004) HVAC Sound And Vibration Manual - First Edition

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 82 Protection of Stratospheric Ozone

1.2 DEFINITIONS

a. AABC: Associated Air Balance Council.

b. COR: Contracting Officer's Representative.

c. DALT: Duct air leakage test

d. DALT'd: Duct air leakage tested

e. HVAC: Heating, ventilating, and air conditioning; or heating, ventilating, and cooling.

f. NEBB: National Environmental Balancing Bureau

g. Out-of-tolerance data: Pertains only to field acceptance testing of Final DALT or TAB report. When applied to DALT work, this phase means a leakage rate measured during DALT field acceptance testing which exceeds the leakage rate allowed. When applied to TAB work this phase means "a measurement taken during TAB field acceptance testing which does not fall within the range of plus 5 to minus 5 percent of the original measurement reported on the TAB Report for a specific parameter."

h. Sound measurements terminology: Defined in AABC MN-1, NEBB MASV, or SMACNA 1858 (TABB).

i. TAB: Testing, adjusting, and balancing (of HVAC systems).

j. TAB'd: HVAC Testing/Adjusting/Balancing procedures performed.

k. TAB Agency: TAB Firm

l. TAB team field leader: TAB team field leader

m. TAB team supervisor: TAB team engineer.

n. TAB team technicians: TAB team assistants.

o. TABB: Testing Adjusting and Balancing Bureau.

1.2.1 Similar Terms

A. In some instances, terminology differs between the Contract and the TAB Standard primarily because the intent of this Section is to use the industry standards specified, along with additional requirements listed herein to produce optimal results.

B. The following table of similar terms is provided for clarification only. Contract requirements take precedent over the corresponding AABC, NEBB, or TABB requirements where differences exist.

SIMILAR TERMS

| Contract Term | AABC Term | NEBB Term | TABB Term |
|---|---|---|---|
| TAB Standard | National Standards For Testing and Balancing Heating, Ventilating, and Air Conditioning Systems | Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems | International Standards for Environmental Systems Balance |
| TAB Specialist | TAB Engineer | TAB Supervisor | TAB Supervisor |
| Systems Readiness Check | Construction Phase Inspection | Field Readiness Check & Preliminary Field Procedures. Prelim. Field Procedures | Field Readiness Check & |

1.3 WORK DESCRIPTION

A. The work includes duct air leakage testing (DALT) and testing, adjusting, and balancing (TAB) of new heating, ventilating, and cooling (HVAC) air distribution systems including equipment and performance data, ducts, and piping which are located within, on, under, between, and adjacent to buildings, including records of existing conditions.

B. Perform TAB in accordance with the requirements of the TAB procedural standard recommended by the TAB trade association that approved the TAB Firm's qualifications. Comply with requirements of AABC MN-1, NEBB PROCEDURAL STANDARDS, or SMACNA 1780 (TABB) as supplemented and modified by this specification section. All recommendations and suggested practices contained in the TAB procedural standards are considered mandatory.

C. Conduct DALT and TAB of the indicated existing systems and equipment and submit the specified DALT and TAB reports for approval. Conduct DALT testing in compliance with the requirements specified in SMACNA 1143, except as supplemented and modified by this section. Conduct DALT and TAB work in accordance with the requirements of this section.

1.3.1 Air Distribution Systems

Test, adjust, and balance systems (TAB) in compliance with this section.

1.3.2 TAB SCHEMATIC DRAWINGS

A. Show the following information on TAB Schematic Drawings:

1. A unique number or mark for each piece of equipment or terminal.

2. Air quantities at air terminals.

3. Ductwork Construction and Leakage Testing Table that defines the DALT test requirements, including each applicable HVAC duct system ID or mark, duct pressure class, duct seal class, and duct leakage test pressure. This table is included in the file for Graphics for Unified Facilities Guide Specifications:
http://www.wbdg.org/ccb/NAVGRAPH/graphtoc.pdf

B. The Testing, Adjusting, and Balancing (TAB) Specialist must review the Contract Plans and Specifications and advise the Contracting Officer of any deficiencies that would prevent the effective and accurate TAB of the system, including records of existing conditions, and systems readiness check. The TAB Specialist must provide a Design Review Report individually listing each deficiency and the corresponding proposed corrective action necessary for proper system operation.

C. Submit three copies of the TAB Schematic Drawings and Report Forms to the Contracting Officer, no later than 21 days prior to the start of TAB field measurements.

1.3.3 Related Requirements

A. Section 23 00 00 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEMS applies to work specified in this section.

B. Specific requirements relating to Reliability Centered Maintenance (RCM) principals and Predictive Testing and Inspection (PTI), by the construction contractor to detect latent manufacturing and installation defects must be followed as part of the Contractor's Quality Control program. Refer to the paragraph titled "Sustainability" for detailed requirements.

1.4 SUBMITTALS

Contracting Officer's written approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Records of Existing Conditions

TAB Firm

Designation of TAB team assistants

Designation of TAB team engineer

Designation of TAB team field leader or TAB Specialist

SD-02 Shop Drawings

TAB Schematic Drawings and Report Forms

SD-03 Product Data

Equipment and Performance Data

TAB Related HVAC Submittals

A list of the TAB Related HVAC Submittals, no later than 7 days after the approval of the TAB team engineer.

TAB Procedures

Proposed procedures for TAB, submitted with the TAB Schematic Drawings and Report Forms.

Calibration

Systems Readiness Check

TAB Execution

TAB Verification

SD-06 Test Reports

DALT and TAB Work Execution Schedule

DALT and TAB Procedures Summary

DALT reports (Appendixes B & C)

TAB reports (Appendixes B & C)

SD-07 Certificates

Independent TAB agency and personnel qualifications

TAB Firm

Independent TAB Agency and Personnel Qualifications

DALT and TAB Submittal and Work Schedule

Advanced notice for TAB field work

Prerequisite HVAC Work Check Out List

## 1.5 QUALITY ASSURANCE

### 1.5.1 Independent TAB Agency and Personnel Qualifications

To secure approval for the proposed agency, submit information certifying that the TAB agency is a first tier subcontractor who is not affiliated with any other company participating in work on this contract, including design, furnishing equipment, or construction. Further, submit the following, for the agency, to Contracting Officer for approval:

a. Independent AABC or NEBB or TABB TAB agency:

TAB agency: AABC registration number and expiration date of current certification; or NEBB certification number and expiration date of current certification; or TABB certification number and expiration date of current certification.

TAB team supervisor: Name and copy of AABC or NEBB or TABB TAB supervisor certificate and expiration date of current certification.

TAB team field leader: Name and documented evidence that the team field leader has satisfactorily performed full-time supervision of TAB work in the field for not less than 3 years immediately preceding this contract's bid opening date.

TAB team field technicians: Names and documented evidence that each field technician has satisfactorily assisted a TAB team field leader in performance of TAB work in the field for not less than one year immediately preceding this contract's bid opening date.

Current certificates: Registrations and certifications are current, and valid for the duration of this contract. Renew Certifications which expire prior to completion of the TAB work, in a timely manner so that there is no lapse in registration or certification. TAB agency or TAB team personnel without a current registration or current certification are not to perform TAB work on this contract.

b. TAB Team Members: TAB team approved to accomplish work on this contract are full-time employees of the TAB agency. No other personnel is allowed to do TAB work on this contract.

c. Replacement of TAB team members: Replacement of members may occur if each new member complies with the applicable personnel qualifications and each is approved by the Contracting Officer.

1.5.2 TAB Standard

A. Perform TAB in accordance with the requirements of the standard under which the TAB Firm's qualifications are approved, i.e., AABC MN-1, NEBB PROCEDURAL STANDARDS, or SMACNA 1780 unless otherwise specified herein. All recommendations and suggested practices contained in the TAB Standard are considered mandatory. Use the provisions of the TAB Standard, including checklists, report forms, etc., as nearly as practical, to satisfy the Contract requirements. Use the TAB Standard for all aspects of TAB, including qualifications for the TAB Firm and Specialist and calibration of TAB instruments. Where the instrument manufacturer calibration recommendations are more stringent than those listed in the TAB Standard, adhere to the manufacturer's recommendations.

B. All quality assurance provisions of the TAB Standard such as performance guarantees are part of this contract. For systems or system components not covered in the TAB Standard, TAB procedures must be developed by the TAB Specialist. Where new procedures, requirements, etc., applicable to the Contract requirements have been published or adopted by the body responsible for the TAB Standard used (AABC, NEBB, or TABB), the requirements and recommendations contained in these procedures and requirements are considered mandatory, including the latest requirements of ASHRAE 62.1.

1.5.3 Qualifications

1.5.3.1 TAB Firm

A. The TAB Firm must be either a member of AABC or certified by the NEBB or the TABB and certified in all categories and functions where measurements or performance are specified on the plans and specifications, including TAB of environmental systems, and building systems commissioning.

B. Certification must be maintained for the entire duration of duties specified herein. If, for any reason, the firm loses subject certification during this period, the Contractor must immediately notify the Contracting Officer and submit another TAB Firm for approval. Any firm that has

been the subject of disciplinary action by either the AABC, the NEBB, or the TABB within the five years preceding Contract Award is not be eligible to perform any duties related to the HVAC systems, including TAB. All work specified in this Section and in other related Sections to be performed by the TAB Firm will be considered invalid if the TAB Firm loses its certification prior to Contract completion and must be performed by an approved successor.

C. These TAB services are to assist the prime Contractor in performing the quality oversight for which it is responsible. The TAB Firm must be a prime subcontractor of the Contractor and be financially and corporately independent of the mechanical subcontractor, reporting directly to and paid by the Contractor.

1.5.3.2 TAB Specialist

The TAB Specialist must be either a member of AABC, an experienced technician of the Firm certified by the NEBB, or a Supervisor certified by the TABB. The certification must be maintained for the entire duration of duties specified herein. If, for any reason, the Specialist loses subject certification during this period, immediately notify the Contracting Officer's Representative and submit another TAB Specialist for approval. Any individual that has been the subject of disciplinary action by either the AABC, the NEBB, or the TABB within the five years preceding Contract Award is not eligible to perform any duties related to the HVAC systems, including TAB. All work specified in this Section and in other related Sections performed by the TAB Specialist will be considered invalid if the TAB Specialist loses its certification prior to Contract completion and must be performed by the approved successor.

1.5.3.3 TAB Specialist Responsibilities

TAB Specialist responsibilities include all TAB work specified herein and in related sections under his direct guidance. The TAB specialist is required to be onsite on a daily basis to direct TAB efforts. The TAB Specialist must participate in the commissioning process specified in Division 1.

1.5.3.4 TAB Related HVAC Submittals

The TAB Specialist must prepare a list of the submittals from the Contract Submittal Register that relate to the successful accomplishment of all HVAC TAB. Accompany the submittals identified on this list with a letter of approval signed and dated by the TAB Specialist when submitted to the Contracting Officer. Ensure that the location and details of ports, terminals, connections, etc., necessary to perform TAB are identified on the submittals.

1.5.4 Responsibilities

The Contractor is responsible for ensuring compliance with the requirements of this section. The following delineation of specific work responsibilities is specified to facilitate TAB execution of the various work efforts by personnel from separate organizations. This breakdown of specific duties is specified to facilitate adherence to the schedule listed in paragraph entitled "TAB Submittal and Work Schedule."

1.5.4.1 Contractor

a. TAB personnel: Ensure that the DALT work and the TAB work is accomplished by a group meeting the requirements specified in paragraph entitled "TAB Personnel Qualification Requirements."

b. HVAC documentation: Furnish one complete set of the following HVAC-related documentation to the TAB agency:

(1) Contract drawings and specifications

(2) Approved submittal data for equipment

(3) Construction work schedule

(4) Up-to-date revisions and change orders for the previously listed items

c. Submittal and work schedules: Ensure that the schedule for submittals and work required by this section and specified in paragraph entitled "TAB Submittal and Work Schedule," is met.

d. Coordination of supporting personnel:

Provide the technical personnel, such as factory representatives or HVAC controls installer required by the TAB field team to support the DALT and the TAB field measurement work.

Provide equipment mechanics to operate HVAC equipment and ductwork mechanics to provide the field designated test ports to enable TAB field team to accomplish the DALT and the TAB field measurement work. Ensure these support personnel are present at the times required by the TAB team, and cause no delay in the DALT and the TAB field work.

Conversely, ensure that the HVAC controls installer has required support from the TAB team field leader to complete the controls check out.

e. Deficiencies: Ensure that the TAB Agency supervisor submits all Design/Construction deficiency notifications directly to the Contracting Officer within 3 days after the deficiency is encountered. Further, ensure that all such notification submittals are complete with explanation, including documentation, detailing deficiencies.

f. Prerequisite HVAC work: Complete check out and debugging of HVAC equipment, ducts, and controls prior to the TAB engineer arriving at the project site to begin the TAB work. Debugging includes searching for and eliminating malfunctioning elements in the HVAC system installations, and verifying all adjustable devices are functioning as designed. Include as prerequisite work items, the deficiencies pointed out by the TAB team supervisor in the design review report.

g. Prior to the TAB field team's arrival, ensure completion of the applicable inspections and work items listed in the TAB team supervisor's pre-field engineering report. Do not allow the TAB team to commence TAB field work until all of the following are completed.

(1) HVAC system installations are fully complete.

(2) HVAC prerequisite checkout work lists specified in the paragraph "Pre-Field TAB Engineering Report" are completed, submitted, and approved. Ensure that the TAB Agency gets a copy of the approved prerequisite HVAC work checklist.

(3) DALT field checks for all systems are completed.

(4) HVAC system filters are clean for TAB field work.

h. Advance notice: Furnish to the Contracting Officer's Representative with advance written notice for the commencement of the DALT field work and for the commencement of the TAB field work.

1.5.4.2 TAB Agency

Provide the services of a TAB team which complies with the requirements of paragraph entitled "Independent TAB Agency Personnel Qualifications". The work to be performed by the TAB agency is limited to testing, adjusting, and balancing of HVAC air systems to satisfy the requirements of this specification section.

1.5.4.3 TAB Team Supervisor

a. Overall management: Supervise and manage the overall TAB team work effort, including preliminary and technical DALT and TAB procedures and TAB team field work.

b. Support required: Specify the technical support personnel required from the Contractor other than the TAB agency; such as factory representatives for temperature controls or for complex equipment. Inform the Contractor in writing of the support personnel needed and when they are needed. Furnish the notice as soon as the need is anticipated, either with the design review report, or the pre-field engineering report, the during the DALT or TAB field work.

c. Prerequisite HVAC work checklist: Ensure the Contractor gets a copy of this checklist at the same time as the pre-field engineering report is submitted.

d. Technical assistance for DALT work.

(1) Technical assistance: Provide immediate technical assistance to TAB field team.

e. Final DALT report: Certify the DALT report. This certification includes the following work:

(1) Prepare the Certified Final DALT report.

(2) TAB Verification: Verify adherence, by the TAB field team, to the procedures specified in this section.

f. Certified TAB report: Certify the TAB report. This certification includes the following work:

(1) Review: Review the TAB field data report. From this field report, prepare the certified TAB report.

(2) Verification: Verify adherence, by the TAB field team, to the TAB plan prescribed by the pre-field engineering report and verify adherence to the procedures specified in this section.

g. Design/Construction deficiencies: Within 3 working days after the TAB Agency has encountered any design or construction deficiencies, the TAB Supervisor must submit written notification directly to the Contracting Officer's Representative and Contracting Officer, with a separate copy to the Contractor, of all such deficiencies. Provide in this submittal a complete explanation, including supporting documentation, detailing deficiencies. Where deficiencies are encountered that are believed to adversely impact successful completion of TAB, the TAB Agency must issue notice and request direction in the notification submittal.

h. TAB Field Check: The TAB team supervisor must attend and supervise TAB field check.

1.5.4.4 TAB Team Field Leader

a. Field manager: Manage, in the field, the accomplishment of the work specified in Part 3, "Execution."

b. Full time: Be present at the contract site when DALT field work or TAB field work is being performed by the TAB team; ensure day-to-day TAB team work accomplishments are in compliance with this section.

c. Prerequisite HVAC work: Do not bring the TAB team to the contract site until a copy of the prerequisite HVAC Checklist, with all work items certified by the Contractor to be working as designed, reaches the office of the TAB Agency.

1.5.5 Test Reports

1.5.5.1 Data from DALT Field Work

Report the data for the Certified Final DALT Report in compliance the following requirements:

a. Report format: Submit report data on Air Duct Leakage Test Summary Report Forms as shown on Page 6-2 of SMACNA 1143. In addition, submit in the report, a marked duct shop drawing which identifies each section of duct tested with assigned node numbers for each section. Include node numbers in the completed report forms to identify each duct section. The TAB supervisor must review and certify the report.

b. The TAB supervisor must include a copy of all calculations prepared in determining the duct surface area of each duct test section. In addition, provide the ductwork air leak testing (DALT) reports with a copy(s) of the calibration curve for each of the DALT test orifices used for testing.

c. Instruments: List the types of instruments actually used to measure the data. Include in the listing each instrument's unique identification number, calibration date, and calibration expiration date. Instruments must have been calibrated within one year of the date of use in the field. Instrument calibration must be traceable to the measuring standards of the National Institute of Standards and Technology.

d. Certification: Include the typed name of the TAB supervisor and the dated signature of the TAB supervisor.

1.5.5.2 Certified TAB Reports

Submit: TAB Report in the following manner:

a. Report format: Submit the completed pre-field data forms approved in the pre-field TAB Engineering Report completed by TAB field team, reviewed and certified by the TAB supervisor. Bind the report with a waterproof front and back cover. Include a table of contents identifying by page number the location of each report. Report forms and report data must be typewritten. Handwritten report forms or report data are not acceptable.

b. Temperatures: On each TAB report form reporting TAB work accomplished on HVAC thermal energy transfer equipment, include the indoor and outdoor dry bulb temperature range and indoor and outdoor wet bulb temperature range within which the TAB data was recorded. Include in the TAB report continuous time versus temperature recording data of wet and dry bulb temperatures for the rooms, or zones, as designated in the following list:

(1) Measure and record data only after the HVAC systems installations are complete, the systems fully balanced and the HVAC systems controls operating in fully automatic mode.

(2) Data may be compiled using direct digital controls trend logging where available. Otherwise, temporarily install calibrated time versus temperature/humidity recorders for this purpose. The HVAC systems and controls must be fully operational a minimum of 24 hours in advance of commencing data compilation. Include the specified data in the Season I and Season 2 TAB Report.

c. System Diagrams: Provide updated diagrams with final installed locations of all terminals and devices, any numbering changes, and actual test locations. Use a key numbering system on the diagram which identifies each outlet contained in the outlet airflow report sheet.

d. Static Pressure Profiles: Report static pressure profiles for air duct systems. Report static pressure data for all supply, return, relief, exhaust and outside air ducts for the systems listed. Include the following in the static pressure report data, in addition to AABC/NEBB/TABB required data:

(1) Report supply fan, return fan, relief fan, and exhaust fan inlet and discharge static pressures.

(2) Report static pressure drop across chilled water coils, DX coils, electric resistance heating coils and heat reclaim devices installed in unit cabinetry or the system ductwork.

(3) Report static pressure drop across outside air, return air, and supply air automatic control dampers, both proportional and two-position, installed in unit cabinetry.

(4) Report static pressure drop across air filters, acoustic silencers, moisture eliminators, air flow straighteners, air flow measuring stations or other pressure drop producing specialty items installed in unit cabinetry, or in the system ductwork. Examples of these specialty items are smoke detectors, white sound generators, RF shielding, wave guides, security bars, blast valves, small pipes passing through ductwork, and duct mounted humidifiers.

Do not report static pressure drop across duct fittings provided for the sole purpose of conveying air, such as elbows, transitions, offsets, plenums, manual dampers, and branch takes-offs.

(5) Report static pressure drop across outside air and relief/exhaust air louvers.

(6) Report static pressure readings of supply air, return air, exhaust/relief air, and outside air in duct at the point where these ducts connect to each air moving unit.

e. Duct Traverses: Report duct traverses for main supply, return, exhaust, relief and outside air ducts. This includes all ducts, including those which lack 7 1/2 duct diameters upstream and 2 1/2 duct diameters downstream of straight duct unobstructed by duct fittings/offsets/elbows. The TAB Agency must evaluate and report findings on the duct traverses taken. Evaluate the suitability of the duct traverse measurement based on satisfying the qualifications for a pilot traverse plane as defined by AMCA 203, "Field Measurements", Section 8, paragraph 8.3, "Location of Traverse Plane."

f. Instruments: List the types of instruments actually used to measure the tab data. Include in the listing each instrument's unique identification number, calibration date, and calibration expiration date.

Instrumentation, used for taking wet bulb temperature readings must provide accuracy of plus or minus 5 percent at the measured face velocities. Submit instrument manufacturer's literature to document instrument accuracy performance is in compliance with that specified.

g. Certification: Include the typed name of the TAB supervisor and the dated signature of the TAB supervisor.

h. Performance Curves: The TAB Supervisor must include, in the TAB Reports, factory pump curves and fan curves for pumps and fans TAB'd on the job.

i. Calibration Curves: The TAB Supervisor must include, in the TAB Reports, a factory calibration curve for installed flow control balancing valves, flow venturi's and flow orifices TAB'd on the job.

## 1.6 SEQUENCING AND SCHEDULING

### 1.6.1 DALT and TAB Submittal and Work Schedule

Comply with additional requirements specified in Appendix C: DALT AND TAB SUBMITTAL AND WORK SCHEDULE included at the end of this section

### 1.6.2 Projects with Phased Construction

This specification section is structured as though the HVAC construction, and thereby the TAB work, will be completed in a single phase. When the construction is completed in phases, the DALT work and TAB work must be planned, completed, and accepted for each construction phase.

#### 1.6.2.1 Phasing of Work

This specification section is structured as though the HVAC construction, and thereby the TAB work, is going to be completed in a single phase in spite of the fact that there will be two seasons. All elements of the TAB work are addressed on this premise. When a contract is to be completed in construction phases, including the TAB work, and the DALT work, the TAB work and DALT work must be planned for, completed and approved by the Contracting Officer with each phase. An example of this case would be one contract that requires the rehabilitation of the HVAC in each of several separated buildings. At the completion of the final phase, compile all approved reports and submit as one document. Completion of all TAB work is required before final report shall be submitted.

### 1.6.3 DALT and TAB Submittal and Work Schedule

A. Submit this schedule, and TAB Schematic Drawings, adapted for this particular contract, to the Contracting Officer for review and approval. Include with the submittal the planned calendar

dates for each submittal or work item. Resubmit an updated version for Contracting Officer approval every 90 calendar days. Compliance with the following schedule is the Contractor's responsibility.

1. Qualify TAB Personnel: Within 45 calendar days after date of contract award, submit TAB agency and personnel qualifications.

2. DALT Field Work: Within 48 hours of COR's selection, complete DALT field work on selected.

3. Submit Final DALT Report: Within 15 calendar days after completion of successful DALT Work Field Check, submit TAB report.

4. Prerequisite HVAC Work Check Out List and Advanced Notice For TAB Field Work: At a minimum of 30 calendar days prior to CCD, submit prerequisite HVAC work check out list certified as complete, and submit advance notice of commencement of TAB field work.

5. TAB Field Work: At a minimum of 30 calendar days prior to CCD, and when the ambient temperature is within limits, accomplish TAB field work.

6. Submit TAB Report: Within 15 calendar days after completion of TAB field work, submit TAB report.

7. TAB Field Check: 30 calendar days after TAB report is approved by the Contracting Officer, conduct Season 1 field check.

## 1.7 WARRANTY

Furnish workmanship and performance warranty for the DALT and TAB system work performed for a period not less than 1 years from the date of Government acceptance of the work; issued directly to the Government. Include provisions that if within the warranty period the system shows evidence of major performance deterioration, or is significantly out of tolerance, resulting from defective TAB or DALT workmanship, the corrective repair or replacement of the defective materials and correction of the defective workmanship is the responsibility of the TAB firm. Perform corrective action that becomes necessary because of defective materials and workmanship while system TAB and DALT is under warranty 7 days after notification, unless additional time is approved by the Contracting Officer. Failure to perform repairs within the specified period of time constitutes grounds for having the corrective action and repairs performed by others and the cost billed to the TAB firm. The Contractor must also provide a 1 year contractor installation warranty.

# PART 2 PRODUCTS

Not Used

## PART 3 EXECUTION

### 3.1 WORK DESCRIPTIONS OF PARTICIPANTS

Comply with requirements of this section as specified in Appendix A WORK DESCRIPTIONS OF PARTICIPANTS.

### 3.2 DALT PROCEDURES

#### 3.2.1 Instruments, Consumables and Personnel

Provide instruments, consumables and personnel required to accomplish the DALT field work. Follow the same basic procedure specified below for TAB Field Work, including maintenance and calibration of instruments, accuracy of measurements, preliminary procedures, field work, workmanship and treatment of deficiencies. Calibrate and maintain instruments in accordance with manufacturer's written procedures.

#### 3.2.2 Ductwork To Be DALT'd

A. From each duct system indicated as subject to DALT, the Contracting Officer's Representative will randomly select sections of each completed duct system for testing by the Contractor's TAB Firm. The sections selected will not exceed 20 percent of the total measured linear footage of duct systems indicated as subject to DALT. Sections of duct systems subject to DALT will include 20 percent of main ducts, branch main ducts, branch ducts and plenums for supply, return, exhaust, and plenum ductwork.

B. It is acceptable for an entire duct system to be DALT'd instead of disassembling that system in order to DALT only the 20 percent portion specified above.

#### 3.2.3 DALT Testing

A. Perform DALT on the HVAC duct sections of each system as selected by the Contracting Officer's Representative. Use the duct class, seal class, leakage class and the leak test pressure data indicated on the drawings, to comply with the procedures specified in SMACNA 1143.

B. In spite of specifications of SMACNA 1143 to the contrary, DALT ductwork of construction class of 3-inch water gauge static pressure and below if indicated to be DALT'd. Complete DALT work on the Contracting Officer's Representative selected ductwork within 48 hours after the particular ductwork was selected for DALT. Separately conduct DALT work for large duct systems to enable the DALT work to be completed in 48 hours.

### 3.3 TAB PROCEDURES

#### 3.3.1 TAB Field Work

A. Test, adjust, and balance the HVAC systems until measured flow rates (air flow) are within plus or minus 5 percent of the design flow rates as specified or indicated on the contract documents.

B. That is, comply with the requirements of AABC MN-1 and AABC MN-4, NEBB PROCEDURAL STANDARDS, NEBB MASV, or SMACNA 1780 (TABB) and SMACNA 1858 (TABB), except as supplemented and modified by this section.

C. Provide instruments and consumables required to accomplish the TAB work. Calibrate and maintain instruments in accordance with manufacturer's written procedures.

D. Test, adjust, and balance the HVAC systems until measured flow rates (air flow) are within plus or minus 5 percent of the design flow rates as specified or indicated on the contract documents. Conduct TAB work, including measurement accuracy, and sound measurement work in conformance with the AABC MN-1 and AABC MN-4, or NEBB TABES and NEBB MASV, or SMACNA 1780 (used by TABB) and SMACNA 1858 sound measurement procedures, except as supplemented and modified by this section.

3.3.2 Preliminary Procedures

Use the approved pre-field engineering report as instructions and procedures for accomplishing TAB field work. TAB engineer is to locate, in the field, test ports required for testing. It is the responsibility of the sheet metal contractor to provide and install test ports as required by the TAB engineer.

3.3.3 TAB Air Distribution Systems

3.3.3.1 Exhaust Fans

Exhaust fan systems including fans, ducts, and grilles for exhaust air.

3.3.4 Workmanship

Conduct TAB work on the HVAC systems until measured flow rates are within plus or minus 5 percent of the design flow rates as specified or indicated on the contract documents. This TAB work includes adjustment of balancing valves, balancing dampers, and sheaves. Further, this TAB work includes changing out fan sheaves and pump impellers if required to obtain air flow rates specified or indicated. If, with these adjustments and equipment changes, the specified or indicated design flow rates cannot be attained, contact the Contracting Officer's Representative for direction.

3.3.5 Deficiencies

A. Strive to meet the intent of this section to maximize the performance of the equipment as designed and installed. However, if deficiencies in equipment design or installation prevent TAB work from being accomplished within the range of design values specified in the paragraph

entitled "Workmanship," provide written notice as soon as possible to the Contractor and the Contracting Officer's Representative and Contracting Officer describing the deficiency and recommended correction.

B. Responsibility for correction of installation deficiencies is the Contractor's. If a deficiency is in equipment design, call the TAB team supervisor for technical assistance. Responsibility for reporting design deficiencies to Contractor is the TAB team supervisor's.

3.3.6 TAB Reports

A. Additional requirements for TAB Reports are specified in Appendix B REPORTS - DALT and TAB.

B. After completion of the TAB field work, prepare the TAB field data for TAB supervisor's review and certification, using the reporting forms approved in the pre-field engineering report. Data required by those approved data report forms is to be furnished by the TAB team. Except as approved otherwise in writing by the Contracting Officer, the TAB work and thereby the TAB report is considered incomplete until the TAB work is accomplished to within the accuracy range specified in the paragraph entitled "Workmanship."

3.3.7 Quality Assurance - Contracting Officer's Representative TAB Field Acceptance Testing

3.3.7.1 TAB Field Acceptance Testing

A. During the field acceptance testing, verify, in the presence of the Contracting Officer's Representative, random selections of data (air quantities, air motion) recorded in the TAB Report. Points and areas for field acceptance testing are to be selected by the Contracting Officer's Representative. Measurement and test procedures are the same as approved for TAB work for the TAB Report.

B. Field acceptance testing includes verification of TAB Report data recorded for the following equipment groups:

Group 1: 25 percent of the return grilles, return registers, exhaust grilles and exhaust registers.

Group 2: 25 percent of the exhaust fans.

C. Further, if any data on the TAB Report for Groups 2 through 5 is found not to fall within the range of plus 5 to minus 5 percent of the TAB Report data, additional group data verification is required in the presence of the Contracting Officer's Representative. Verify TAB Report data for one additional piece of equipment in that group. Continue this additional group data verification until out-of-tolerance data ceases to be found.

3.3.7.2 Additional Contracting Officer's Representative TAB Field Acceptance Testing

A. If any of the acceptance testing measurements for a given equipment group is found not to fall within the range of plus 5 to minus 5 percent of the TAB Report data, terminate data verification for all affected data for that group. The affected data for the given group will be disapproved. Make the necessary corrections and prepare a revised TAB Report. Reschedule acceptance testing of the revised report data with the Contracting Officer's Representative.

B. Further, if any data on the TAB Report for a given field acceptance test group is out-of-tolerance, then field test data for one additional field test group as specified herein. Continue this increase field test work until out-of-tolerance data ceases to be found. This additional field testing is up and above the original 25 percent of the reported data entries to be field tested.

C. If there are no more similar field test groups from which to choose, additional field testing from another, but different, type of field testing group must be tested.

3.3.7.3 Prerequisite for Approval

Compliance with the field acceptance testing requirements of this section is a prerequisite for the final Contracting Officer approval of the TAB Report submitted.

## 3.4 MARKING OF SETTINGS

Upon the final TAB work approval, permanently mark the settings of HVAC adjustment devices including valves, gauges, splitters, and dampers so that adjustment can be restored if disturbed at any time. Provide permanent markings clearly indicating the settings on the adjustment devices which result in the data reported on the submitted TAB report.

## 3.5 MARKING OF TEST PORTS

The TAB team is to permanently and legibly mark and identify the location points of the duct test ports. If the ducts have exterior insulation, make these markings on the exterior side of the duct insulation. Show the location of test ports on the as-built mechanical drawings with dimensions given where the test port is covered by exterior insulation.

## 3.6 APPENDICES

Appendix A WORK DESCRIPTIONS OF PARTICIPANTS
Appendix B REPORTS - DALT and TAB
Appendix C DALT AND TAB SUBMITTAL AND WORK SCHEDULE

Appendix A

WORK DESCRIPTIONS OF PARTICIPANTS

The Contractor is responsible for ensuring compliance with all requirements of this specification section. However, the following delineation of specific work items is provided to facilitate and co-ordinate execution of the various work efforts by personnel from separate organizations.

1. Contractor

   a. HVAC documentation: Provide pertinent contract documentation to the TAB Firm, to include the following: the contract drawings and specifications; copies of the approved submittal data for all HVAC equipment, air distribution devices, and air measuring/balancing devices; the construction work schedule; and other applicable documents requested by the TAB Firm. Provide the TAB Firm copies of contract revisions and modifications as they occur.

b. Schedules: Ensure the requirements specified under the paragraph "DALT and TAB Schedule" are met.

c. Coordinate Support: Provide and coordinate support personnel required by the TAB Firm in order to accomplish the DALT and TAB field work. Support personnel may include factory representatives, HVAC controls installers, HVAC equipment mechanics, sheet metal workers, pipe fitters, and insulators. Ensure support personnel are present at the work site at the times required.

d. Correct Deficiencies: Ensure the notifications of Construction Deficiencies are provided as specified herein. Refer to the paragraph entitled "Construction Deficiencies." Correct each deficiency as soon as practical with the Contracting Officer's Representative, and submit revised schedules and other required documentation.

e. Pre-TAB Work Checklists: Complete check out and debugging of HVAC equipment, ducts, and controls prior to the TAB engineer arriving at the project site to begin the TAB work. Debugging includes searching for and eliminating malfunctioning elements in the HVAC system installations, and verifying all adjustable devices are functioning as designed. Include as pre-TAB work checklist items, the deficiencies pointed out by the TAB team supervisor in the design review report.

   Prior to the TAB field team's arrival, ensure completion of the applicable inspections and work items listed in the TAB team supervisor's DALT and TAB Work Procedures Summary. Do not allow the TAB team to commence TAB field work until all of the following are completed.

f. Give Notice of Testing: Submit advance notice of TAB field work accompanied by completed prerequisite HVAC Work List

g. Insulation work: Ensure that no insulation is shall not be installed on ducts to be DALT'd until DALT work on the subject ducts is complete.

Ensure the duct and piping systems are properly insulated and vapor sealed upon the successful completion and acceptance of the DALT and TAB work.

2. TAB Team Supervisor

a. Overall management: Supervise and manage the overall TAB team work effort, including preliminary and technical DALT and TAB procedures and TAB team field work.

b. Schedule: Ensure the requirements specified under the paragraph "DALT and TAB Schedule" are met.

c. Submittals: Provide the submittals specified herein.

d. Support required: Specify the technical support personnel required from the Contractor other than the TAB agency; such as factory representatives for temperature controls or for complex equipment. Inform the Contractor in writing of the support personnel needed and when they are needed. Furnish the notice as soon as the need is anticipated, either with the design review report, or the DALT and TAB Procedures Summary, the during the DALT or TAB field work.

Ensure the Contractor is properly notified and aware of all support personnel needed to perform the TAB work. Maintain communication with the Contractor regarding support personnel throughout the duration of the TAB field work, including the TAB field acceptance testing checking.

Ensure all inspections and verifications for the Pre-Final DALT and Pre-TAB Checklists are completely and successfully conducted before DALT and TAB field work is performed.

e. Advance Notice: Monitor the completion of the duct system installations and provide the Advance Notice for Pre-Final DALT field work as specified herein.

f. Technical Assistance: Provide technical assistance to the DALT and TAB field work.

g. Deficiencies Notification: Ensure the notifications of Construction Deficiencies are provided as specified herein. Comply with requirements of the paragraph entitled "Construction Deficiencies." Resolve each deficiency as soon as practical and submit revised schedules and other required documentation.

h. Procedures: Develop the required TAB procedures for systems or system components not covered in the TAB Standard.

3. TAB Team Field Leader

a. Field manager: Manage, in the field, the accomplishment of the work specified in Part 3, "Execution."

b. Full time: Be present at the contract site when DALT field work or TAB field work is being performed by the TAB team; ensure day-to-day TAB team work accomplishments are in compliance with this section.

c. Prerequisite HVAC work: Do not bring the TAB team to the contract site until a copy of the prerequisite HVAC work list, with all work items certified by the Contractor to be working as designed, reaches the office of the TAB Agency.

Appendix B

REPORTS - DALT and TAB

All submitted documentation must be typed, neat, and organized. All reports must have a waterproof front and back cover, a title page, a certification page, sequentially numbered pages throughout, and a table of contents. Tables, lists, and diagrams must be titled. Generate and submit for approval the following documentation:

1. DALT and TAB Work Execution Schedule

Submit a detailed schedule indicating the anticipated calendar date for each submittal and each portion of work required under this section. For each work entry, indicate the support personnel (such as controls provider, HVAC mechanic, etc.) that are needed to accomplish the work. Arrange schedule entries chronologically.

2. DALT and TAB Procedures Summary

Submit a detailed narrative describing all aspects of the DALT and TAB field work to be performed. Clearly distinguish between DALT information and TAB information. Include the following:

a. A list of the intended procedural steps for the DALT and TAB field work from start to finish. Indicate how each type of data measurement will be obtained. Include what Contractor support personnel are required for each step, and the tasks they need to perform.

b. A list of the project's submittals that are needed by the TAB Firm in order to meet this Contract's requirements.

c. The schematic drawings to be used in the required reports, which may include building floor plans, mechanical room plans, duct system plans, and equipment elevations. Indicate intended TAB measurement locations, including where test ports need to be provided by the Contractor.

d. The data presentation forms to be used in the report, with the preliminary information and initial design values filled in.

e. A list of DALT and TAB instruments to be used, edited for this project, to include the instrument name and description, manufacturer, model number, scale range, published accuracy, most recent calibration date, and what the instrument will be used for on this project.

f. A thorough checklist of the work items and inspections that need to be accomplished before DALT field work can be performed.

g. The checklists specified above shall be individually developed and tailored specifically for the work under this contract. Refer to NEBB PROCEDURAL STANDARDS, Section III, "Preliminary TAB Procedures" under the paragraphs titled, "Air Distribution System Inspection" and "Hydronic Distribution System Inspection" for examples of items to include in the checklists.

3. Final DALT Report

On successful completion of all COR field checks of the Pre-final DALT Report data for all systems, the TABS Supervisor shall assemble, review, sign and submit the Final DALT Report to the Contracting Officer's Representative for approval.

4. TAB Reports: Submit TAB Report for Season 1 and TAB Report for Season 2 in the following manner:

a. Procedure Summary: Submit a copy of the approved DALT and TAB Procedures Summary. When applicable, provide notations describing how actual field procedures differed from the procedures listed.

b. Report format: Submit the completed data forms approved in the pre-field TAB Engineering Report completed by TAB field team, reviewed, approved and signed by the TAB supervisor. Bind the report with a waterproof front and back cover. Include a table of contents identifying by page number the location of each report. Report forms and report data shall be typewritten. Handwritten report forms or report data are not acceptable.

c. Temperatures: On each TAB report form reporting TAB work accomplished on HVAC thermal energy transfer equipment, include the indoor and outdoor dry bulb temperature range and indoor and outdoor wet bulb temperature range within which the TAB data was recorded.

(1) Data shall be measured and compiled on a continuous basis for the period in which TAB work affecting those rooms is being done.

(2) Data shall be measured/recorded only after the HVAC systems installations are complete, the systems fully balanced and the HVAC systems controls operating in fully automatic mode. Provide a detailed explanation wherever a final measurement did not achieve the required value.

(3) Data may be compiled using direct digital controls trend logging where available. Otherwise, the Contractor shall temporarily install calibrated time versus temperature/humidity recorders for this purpose. The HVAC systems and controls shall have been fully operational a minimum of 24 hours in advance of commencing data compilation. The specified data shall be included in the Season I and Season 2 TAB Report.

d. Air System Diagrams: Provided updated diagrams with final installed locations of all terminals and devices, any numbering changes, and actual test locations.

e. Air Static Pressure Profiles: Report static pressure profiles for air duct systems. Report static pressure data for all supply, return, relief, exhaust and outside air ducts for the systems listed. The static pressure report data shall include, in addition to AABC or NEBB or TABB required data, the following:

(1) Report fan inlet and discharge static pressures.

(2) Report static pressure drop across chilled water coils, DX coils, hot water coils, steam coils, electric resistance heating coils and heat reclaim devices installed in unit cabinetry or the system ductwork.

(3) Report static pressure drop across automatic control dampers, both proportional and two-position, installed in unit cabinetry.

(4) Report static pressure drop across air filters, acoustic silencers, moisture eliminators, air flow straighteners, air flow measuring stations or other pressure drop producing specialty items installed in unit cabinetry, or in the system ductwork. Examples of these specialty items are smoke detectors, white sound generators, RF shielding, wave guides, security bars, blast valves, small pipes passing through ductwork, and duct mounted humidifiers.

Do not report static pressure drop across duct fittings provided for the sole purpose of conveying air, such as elbows, transitions, offsets, plenums, manual dampers, and branch takes-offs.

(5) Report static pressure drop across outside air and relief/exhaust air louvers.

(6) Report static pressure readings of air in duct at the point where these ducts connect to each air moving unit.

f. Instruments: List the types of instruments actually used to measure the tab data. Include in the listing each instrument's unique identification number, calibration date, and calibration expiration date.

Instrumentation, used for taking wet bulb temperature readings shall provide accuracy of plus or minus 5 percent at the measured face velocities. Submit instrument manufacturer's literature to document instrument accuracy performance is in compliance with that specified.

g. Performance Curves: The TAB Supervisor shall include, in the TAB Reports, factory pump curves and fan curves for pumps and fans TAB'd on the job.

h. Calibration Curves: The TAB Supervisor shall include, in the TAB Reports, a factory calibration curve for installed flow control balancing valves, flow venturis and flow orifices TAB'd on the job.

i. Data From TAB Field Work: After completion of the TAB field work, prepare the TAB field data for TAB supervisor's review and approval signature, using the reporting forms approved in the pre-field engineering report. Data required by those approved data report forms shall be furnished by the TAB team. Except as approved otherwise in writing by the Contracting Officer, the TAB work and thereby the TAB report shall be considered incomplete until the TAB work is accomplished to within the accuracy range specified in the paragraph entitled "Workmanship."

Appendix C

DALT AND TAB SUBMITTAL AND WORK SCHEDULE

Perform the following items of work in the order listed adhering to the dates schedule specified below.

a. Submit TAB Agency and TAB Personnel Qualifications: Within 42 calendar days after date of contract award.

b. Submit the DALT and TAB Work Execution Schedule: within 14 days after receipt of the TAB agency and TAB personnel qualifications approval. Revise and re-submit this schedule 28 days prior to commencement of DALT work and 28 days prior to the commencement of TAB Season 1 work and TAB Season 2 work.

c. Submit the DALT and TAB Work Procedures Summary: within 14 days after receipt of the initial approved DALT and TAB Work Execution Schedule.

d. Conduct measurements and submit the Record of Existing Facility Conditions: within 28 days after receipt of approved DALT and TAB Work Procedures Summary.

e. Ductwork Selected for DALT: Within 14 calendar days after receiving an acceptable completed Pre-Final DALT Work Checklist, the Contracting Officer's Representative (COR) will select the project ductwork sections to be DALT'd.

f. DALT Field Work: Within 48 hours of COR's selection, complete DALT field work on selected project ductwork.

g. Submit Final DALT Report: Within 14 calendar days after completion of successful DALT Work Field Check, submit Season 1 TAB report.

-- End of Section 23 05 93 --

SECTION 23 09 53
SPACE TEMPERATURE CONTROL SYSTEMS

PART 1 GENERAL

1.1 REFERENCES

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

ASME INTERNATIONAL (ASME)

| | |
|---|---|
| ASME B16.18 | (2012) Cast Copper Alloy Solder Joint Pressure Fittings |
| ASME B16.22 | (2001; R 2010) Standard for Wrought Copper and Copper Alloy Solder Joint Pressure Fittings |
| ASME B16.26 | (2011) Standard for Cast Copper Alloy Fittings for Flared Copper Tubes |
| ASME B31.1 | (2012) Power Piping |
| ASME B31.5 | (2010) Refrigeration Piping and Heat Transfer Components |
| ASME B40.100 | (2005; R 2010) Pressure Gauges and Gauge Attachments |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM B32 | (2008) Standard Specification for Solder Metal |
| ASTM B75/B75M | (2011) Standard Specification for Seamless Copper Tube |
| ASTM B88 | (2009) Standard Specification for Seamless Copper Water Tube |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| NEMA 250 | (2008) Enclosures for Electrical Equipment (1000 Volts Maximum) |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 70 | (2014; AMD 1 2013; Errata 1 2013; AMD 2 2013; Errata 2 2013; AMD 3 2014; Errata 3 2014) National Electrical Code |

| | |
|---|---|
| NFPA 90A | (2012) Standard for the Installation of Air Conditioning and Ventilating Systems |

## 1.2 SYSTEM DESCRIPTION

Provide new and modify existing space temperature control systems complete and ready for operation.

## 1.3 SYSTEM REQUIREMENTS

A. Provide control systems composed of any combination of electric, analog, and electronic devices. Indicated control system devices of a particular type do not intend a requirement for the device unless the requirement is specifically indicated. Requirements apply to field installed control systems.

B. Inspect and test reused portions of existing control systems, and furnish a report to the Government identifying all inoperative components or system deficiencies. The report shall include a cost estimate to correct deficiencies, scheduled need dates for equipment shutdown for repairs and connection to existing controls and systems. Proceed with repairs only after receipt of Contracting Officer’s Representative approval. Diagnose and report any malfunctions of existing control system device that occurs after the work commences. The Government is responsible for maintenance and repair of Government equipment. The Contractor shall be held responsible for repair costs due to Contractor negligence or abuse of Government equipment.

## 1.4 PERFORMANCE REQUIREMENTS

Provide control systems to maintain the required heating, ventilating, and cooling (HVAC) conditions by performing the functions and sequences of operations indicated. Control systems shall be complete, including all equipment and appurtenances, and ready for operation. Control systems shall be furnished, installed, tested, calibrated, and started up by, or under the supervision of trained technicians certified by the Contractor as qualified and regularly employed in such work. Control system equipment, valves, panels and dampers shall bear the manufacturer's nameplate.

## 1.5 DESIGN REQUIREMENTS

### 1.5.1 Control System Diagrams

For each system, indicate HVAC process flow and location of devices relative to flow and to the HVAC control panel, the connections of control devices in control loops, references of control device contacts and device operating coils to line numbers of a ladder diagram and sequencing diagrams showing the operation of valves, dampers, and contacts relative to controller output, and HVAC process variables.

1.5.2 Ladder Diagram

Indicate connections and interlocks to control system devices and other devices such as starters, drives, HVAC control system panels, and HVAC equipment panels. Diagram shall be coordinated by line number and device number with each control system diagram.

1.5.3 Operating Parameters

Indicate operating parameters for devices shown on the control system diagram such as setpoints, ranges, limits, differentials, outside air temperature schedules, contact operating points, and HVAC equipment operating time schedules.

1.5.4 Wiring Diagram

Indicate terminal blocks, wire marker identification, connections to control system devices, external and internal power sources, and connections to external devices, starters, drives, control panels, jumpers, and ground connections.

1.5.5 Sequence of Operation

Sequence of operation for each HVAC control system coordinated with device identifiers on control system diagram and ladder diagram.

1.5.6 Arrangement Drawing

Arrangement diagram of each HVAC control system panel coordinated with device identifiers on the control system diagram and the ladder diagram.

1.6 SUBMITTALS

Contracting Officer's written approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Control system diagrams for each HVAC system

Ladder diagram

Operating parameters

Sequence of operation

Arrangement drawing

Wiring diagram

SD-03 Product Data

Fire protection devices

Thermostats

Indicating devices

Control panels

SD-06 Test Reports

Site testing procedures identifying each item tested and describing each test

Performance verification test plans and procedures

SD-07 Certificates

Certification of completion

SD-10 Operation and Maintenance Data

Space temperature control system

Submit in accordance with Section 01 78 23 OPERATING INSTRUCTIONS AND TRAINGING.

SD-11 Closeout Submittals

Qualified service organization list

## 1.7 QUALITY ASSURANCE

### 1.7.1 Standard Products

a. Material and equipment shall be standard products of manufacturers regularly engaged in the manufacturing of such products, using similar materials, design and workmanship. The standard products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year use shall include applications of similarly sized equipment and materials used under similar circumstances.

The 2 years experience must be satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures. Products having less than a 2-year field service record will be

acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown.

b. The equipment items shall be supported by a service organization.

1.7.2 Nameplates and Tags

a. Provide nameplates bearing legends as shown and tags bearing device unique identifiers as shown shall have engraved or stamped characters. Nameplates shall be mechanically attached to HVAC control panel doors.

b. A plastic or metal tag shall be mechanically attached directly to each field-mounted device or attached by a metal chain or wire.

c. Each airflow measurement station shall have a tag showing flow rate range for signal output range, duct size, and device identifier where shown.

1.7.3 Verification of Dimensions

Contractor shall become familiar with details of work, shall verify dimensions in the field, and shall advise Contracting Officer's Representative and Contracting Officer of any discrepancy before performing work.

1.7.4 Modification of References

Accomplish work in accordance with ASME B31.1, ASME B31.5, NFPA 70, and NFPA 90A, except as modified herein or indicated otherwise for equipment, materials, installation, examination, inspection, and testing. Consider the advisory or recommended provisions to be mandatory, as though the word "shall" had be substituted for the words "should" or "could" or "may," wherever they appear. Interpret reference to "authority having jurisdiction" and "owner" to mean the Contracting Officer.

1.7.5 Site Testing Procedures

Indicate test equipment to be used including manufacturers' names and model numbers, date of last calibration, and accuracy of calibration.

1.7.6 Space Temperature Control System

In addition to the requirements specified in the paragraph entitled "SUBMITTALS", meet the following requirements. Submit Operation and Maintenance Manuals for items of equipment listed under paragraph entitled "Product Data." Manual shall contain full hardware support documentation, which shall include but not be limited to the following:

a. General description and specifications

b. Installation and initial checkout procedures

c. Detailed electrical and logical description

d. Troubleshooting procedures, diagrams, and guidelines

e. Alignment and calibration procedures for components

f. Preventive maintenance requirements and a maintenance checklist

g. Detailed schematics and assembly drawings

h. Spare parts list data, including required tool kits and suggested method of repairs such as field repair, factory repair, or item replacement

i. Signal identification and timing diagrams

j. Complete as-built control drawings, schedules, and sequence of operation

k. Controller configuration and parameter setting procedures

l. Step-by-step procedures required for each HVAC control systems startup, operation, shutdown, recovery, and fault diagnosis

m. Manufacturer supplied operator manuals for equipment

n. Qualified service organization list

## PART 2 PRODUCTS

### 2.1 COMPONENTS

Provide components factory ordered for this project. Rebuilt equipment, warehoused equipment, or earlier generation equipment shall not be acceptable. Electrical, electronic, and electropneumatic devices not located within control panels shall have a NEMA 250 Type 1 enclosure in accordance with NEMA 250 unless otherwise specified. Actuators and positive positioners, and transmitters shall operate within temperature limit ratings of plus 35 to 150 degrees F. Panel mounted instruments shall operate within limit ratings of 35 to 120 degrees F and 10 percent to 95 percent relative humidity, noncondensing. Devices installed outdoors shall operate within limit ratings of minus 35 to 150 degrees F.

### 2.2 FIRE PROTECTION DEVICES

Provide smoke detectors in return and supply air ducts on the downstream side of the filters in accordance with NFPA 90A, except as otherwise indicated. Provide UL listed or FM approved detectors for duct installation.

2.2.1 Smoke Detectors

A. Provide in each air-handling system with supply air capacity greater than 944 L/s 2000 cfm in accordance with NFPA 90A. Locate downstream of the supply air filters and prior to any branch connection in accordance with NFPA 72.

B. Provide in each air-handling system, serving more than one story, and having a return air capacity greater than 7079 L/s 15000 cfm in accordance with NFPA 90A. Locate at each story prior to connection to common return and at return connection to air handler prior to any fresh air inlet connection and prior to any recirculation connection in accordance with NFPA 72. Design for detection of abnormal smoke densities by the ionization or photoelectric principle, responsive to both invisible and visible particles of combustion, and not susceptible to undesired operation by changes to relative humidity.

C. Provide UL listed or FM approved detectors for duct installation. Provide duct detectors with an approved duct housing, mounted exterior to the duct, and with perforated sampling tubes extending across the width of the duct. Provide permanent descriptive zone labels indicating in which air-handling units the detectors in alarm are located.

D. Provide detectors with a test port, test switch and remote keyed test device. Provide control and power modules required for operation of detectors in their own control unit. A ground fault or single break or open condition in electrical circuitry to any detector or its control or power units shall cause activation of building fire alarm control panel trouble signals.

E. Electrical supervision of wiring used exclusively for air-handling unit shutdown is not required provided a break in wiring would cause shutdown of the associated unit. Equipment and devices shall be compatible and operable in all respects with, and shall in no way impair reliability or operational functions of, the existing building fire alarm system.

2.3 THERMOSTATS

Provide thermostats.

2.3.1 Ranges

Thermostat ranges shall be selected so that the setpoint is adjustable between plus or minus 10 degrees F of the setpoint indicated.

2.3.2 Nonmodulating Electric Room Thermostats

Contacts shall be single-pole double-throw (SPDT), hermetically sealed, and wired to identified terminals. Maximum differential shall be 2 degrees F. Thermostat covers shall consist of locking metal or heavy-duty plastic, and shall be capable of being locked by an Allen wrench or special tool. Thermostats shall have manual switches as required by the application and a minimum range of 55 to 90 degrees F.

2.3.3 Nonmodulating Capillary Thermostats and Aquastats

a. Thermostat shall have a capillary length of at least 5 feet, adjustable direct reading scales for both setpoint and differential, and a differential adjustable from 6 to 16 degrees F.

b. Aquastats shall be strap-on type, with 10 degrees F fixed differential.

2.3.4 Low-Temperature Protection Thermostats (Freezestats)

Low-temperature protection thermostats shall be manually reset low-temperature safety thermostats, with NO and NC contacts or a two-position pneumatic output signal and a 20 foot element which shall respond to the coldest 18 inch segment.

2.4 INDICATING DEVICES

Provide indicating devices.

2.4.1 Thermometers

a. Thermometers for insertion in ductwork and piping systems shall have brass, malleable iron, or aluminum alloy case and frame, clear protective face, and permanently stabilized glass tube with an indicating fluid column, white face, black numbers, and a 9 inch scale.

b. Thermometers for piping systems shall have rigid stems with straight, angular, or inclined pattern.

c. Thermometer stems shall have expansion heads as required to prevent breakage at extreme temperatures. On rigid stem thermometers, the space between bulb and stem shall be filled with a heat transfer medium.

d. Air duct thermometers shall have perforated stem guards and 45 degree adjustable duct flanges with locking mechanisms.

e. Averaging thermometers shall have 3.5 inch (nominal) dial, with black legend on white background, and pointer traveling through a 270 degree arc.

f. Thermometers shall have an accuracy of plus or minus one percent of scale range. Thermometers shall have the following ranges:

(1) Mixed air temperature: 0 to 100 degrees F in 1 degree F graduations.

(2) Return air temperature: 0 to 100 degrees F in 1 degree F graduations.

(3) Cooling coil discharge temperature: 0 to 100 degrees F in 1 degree F graduations.

(4) Chilled water temperature: 0 to 100 degrees F in one degree F graduations.

(5) High temperature hot water: 100 to 550 degrees F in 5 degree F graduations.

2.4.2 Pressure Gages

Provide pressure gages with gage cock, snubber, and syphon.

a. ASME B40.100. Gages shall be 2 1/2 inch (nominal) size, back-connected, suitable for field or panel mounting as required, shall have black legend on white background, and shall have a pointer traveling through a 270 degree arc. Accuracy shall be plus or minus 3 percent of scale range.

b. Gages for indicating signal output to pneumatic actuators and main air gages shall have scale of 0 to 30 psig in 1 psig graduations.

2.5 HVAC SYSTEM CONTROL PANELS

Provide HVAC system control panels.

2.5.1 Panel Assembly

Panel shall be fabricated for bottom entry connection for control system electric power, control system main air source, control system wiring, pneumatic tubing, interconnection of control systems, interconnection of starters, and external shutdown devices. Panel shall have an operating temperature rise of not greater than 20 degrees F above an ambient temperature of 100 degrees F.

2.5.2 Panel Electrical Requirements

Control panel shall be powered by nominal 120 Vac terminating at panel on terminal blocks. Instrument cases shall be grounded. Interior and exterior panel enclosures shall be grounded.

2.5.3 Enclosures

Enclosures for each panel shall be a single door, wall-mounted box conforming to NEMA 250 with a continuous hinged and gasketed exterior door with a print pocket, key lock, and interior back panel. Inside finish shall be white enamel, and outside finish shall be gray primer over phosphatized surfaces.

2.5.4 Mounting and Labeling

Provide pilot lights, switches, panel-mounted control devices, and pressure gages shall be mounted on the door. Power conditioners, fuses, and duplex outlets shall be mounted on the interior of the cabinet. Other components housed in the panel shall be mounted on the interior

back panel surface of the enclosure and shall be identified by plastic or metal nameplates which are mechanically attached to the panel. Lettering shall be cut or stamped into the nameplate to a depth of not less than 1/64 inch, and shall have contrasting color, produced by filling with enamel or lacquer or by use of laminated material. Painting of lettering directly on the surface of the door or interior back panel is not permitted.

2.5.5 Wiring and Tubing

a. Pneumatic device inputs and outputs shall be piped to bulkhead fittings in the bottom of the panel with a 2 inch loop to facilitate replacement. Electric, electronic, and electropneumatic device signals entering and leaving the panel shall be wired to identified terminal blocks.

b. Wiring shall be installed in wiring ducts so that devices can be added or replaced without disturbing existing wiring that is not affected by the change. Wiring to single-loop controllers shall have a 4 inch wiring loop in the horizontal wiring duct at each wiring connection. There shall be no wiring splices within the control panel. Interconnections required for power or signals shall be made on device terminals, if available, or panel terminal blocks, with not more than two wires connected to each terminal.

c. Instrument signal grounds at the same reference level shall end at a grounding terminal connected to a common ground point for that level. Wiring shield grounds at the same reference level shall end at a grounding terminal connected to a common ground point for that level. Grounding terminal blocks shall be identified by reference level.

d. Wiring connected to controllers shall be identified by function and polarity, e.g., process variable input and remote setpoint input and output.

2.6 CONTROL TUBING AND WIRING

Provide HVAC control tubing and wiring.

2.6.1 Tube and Fittings

2.6.1.1 Copper Tubing

ASTM B75/B75M or ASTM B88. Tubing 0.375 inch outside diameter and larger shall have a minimum wall thickness equal to ASTM B88, Type M. Tubing less than 0.375 inch outside diameter shall have a minimum wall thickness of 0.025 inch. Concealed tubing shall be hard or soft copper; multiple tubing shall be racked or bundled. Exposed tubing shall be hard copper; rack multiple tubing. Tubing for working pressures greater than 30 psig shall be hard copper. Bundled tubing shall have each tube numbered each six feet minimum. Racked and individual tubes shall be permanently identified at each end. Fittings shall be solder type ASME B16.18 or ASME B16.22, using ASTM B32, Plumbing Code approved lead-free solder, or compression type ASME B16.26.

2.6.2 Wiring

a. Terminal blocks shall be insulated, modular, feed-through, clamp style with recessed captive screw-type clamping mechanisms. Terminal blocks shall be rail mounted, and shall have end plates, partition plates or enclosed sides for separation.

b. Control wiring for 24-V circuits shall be 18 AWG minimum and shall be rated for 300-V service.

c. Wiring for circuits operating at more than 100 V shall be 14 AWG minimum and shall be rated for 600-V service.

d. Analog signal wiring circuits within control panels shall not be less than 20 AWG and shall be rated for 300-V service.

e. Instrumentation cable shall be 18 AWG, stranded copper, single or multiple twisted, minimum 2-inch lay of twist, 100 percent shielded pairs, and shall have 300-V insulation. Each pair shall have a 20-AWG tinned copper drain wire, individual pair, and overall insulation. Cables shall have an overall aluminum polyester or tinned overall copper cable shield tape, 20-AWG tinned-copper cable drain wire, and overall cable insulation.

f. Nonconducting wiring ducts in control panels shall have slotted side snap-on covers, fittings for connecting ducts, mounting clips for securing ducts, and wire retaining clips.

PART 3 EXECUTION

3.1 INSTALLATION

Perform installation under the supervision of competent technicians regularly employed in the installation of control systems. Provide components for a complete and operational control system. Provide control system complete and ready for operation, as specified and indicated. Provide dielectric isolation where dissimilar metals are used for connection and support. Penetrations through and mounting holes in the building exterior shall be watertight. Control system installation shall provide adequate clearance for control system maintenance by maintaining access spaces between coils, to mixed-air plenums, and as required to calibrate, remove, repair, or replace control system devices. Control system installation shall not interfere with the clearance requirements for mechanical and electrical system maintenance. Install devices mounted in or on piping or ductwork, on building surfaces, in mechanical and electrical spaces, or in occupied space ceilings in accordance with manufacturer's recommendations and as indicated on contract documents. Provide control devices to be installed in piping and ductwork with required gaskets, flanges, thermal compounds, insulation, piping, fittings, and manual valves for shutoff, equalization, purging, and calibration. Certify that installation of control system is complete and technical requirements of this section have been met.

3.1.1 Sensors

3.1.1.1 Low-Temperature Protection Thermostats (Freezestats)

Provide thermostat for each 80 square feet of coil-face area to sense the temperature at location indicated. Install thermostat sensing element in serpentine pattern.

3.1.2 Thermometers

Provide thermometers which are installed in liquid systems in thermowells with thermal transmitting materials within the well to speed the response of temperature measurement.

3.1.3 Pressure Gages

Provide snubbers for gages in piping systems subject to pulsation. Gages for steam service shall have pigtail fittings with cocks. Install pressure gages at locations indicated. Pneumatic output lines shall have pressure gages mounted near the control panel.

3.1.4 Access Doors

Provide access doors in ductwork to service airflow monitoring devices, devices with averaging elements, and low-temperature protection thermostats (freezestats).

3.1.5 Tubing

a. Provide control system so that pneumatic lines are not exposed to air temperatures below 25 degrees F. Install tubes and tube bundles exposed to view neatly in lines parallel to lines of the building. Route tubing between panels and actuators in mechanical and electrical spaces so that lines are easily traceable. Tubes shall be permanently tagged on both ends with an identifier indicated on shop drawings. Install concealed tubing in finished areas, and install exposed tubing in unfinished areas such as mechanical equipment rooms.

b. Pneumatic lines in mechanical and electrical spaces shall be plastic tubing or copper tubing. Install horizontal and vertical runs of plastic tubes or soft copper tubing in raceways dedicated to tubing. Dedicated raceways shall be supported every 6 feet of horizontal run and every 8 feet for vertical runs. Tubing not installed in raceways shall be hard-drawn copper tubing with sweat fittings and valves, supported every 6 feet of horizontal run and every 8 feet for vertical runs.

c. Tubing for final connection of sensing elements and transmitters to ductwork shall be plastic with a maximum length of 12 inches.

d. Tubing external to mechanical and electrical spaces, where run in plenum ceilings, shall be soft copper with sweat fittings, supported every 8 feet. Tubing not in plenum

spaces shall be soft copper with sweat fittings supported every 8 feet or shall be plastic tubing in raceways dedicated to tubing.

e. Provide tubing in concrete in rigid conduit. Install tubing in walls containing insulation, fill, or other packing materials in raceways dedicated to tubing.

f. Final connections to actuators shall be plastic tubing, a maximum of 12 inches long and unsupported at the actuator.

g. Provide a manual valve at each HVAC control panel to allow shutoff of main air. Pneumatic connections to HVAC control panels shall be made using bulkhead fittings except where bundled tubing is being used.

h. Final connections to HVAC control panel bulkhead fittings shall be exposed tubing approximately 12 inches long.

i. Tubing and two insulated copper phone wires for installation checkout may be run in the same conduit. Tubing and electrical power conductors shall not be run in the same conduit. Control circuit conductors, 24 V or less, may be run in the same conduit as polyethylene tubing.

3.1.6 Wiring

a. Provide wiring external to control panels, including low-voltage wiring, in metallic raceways. Install wiring without splices between sensors, transmitters, control devices, and HVAC control panels. Install instrumentation grounding as necessary to prevent ground loops, noise, and surges adversely affecting operation of the system. Tag cables, conductors, and wires at both ends, with identifiers indicated on shop drawings.

3.1.7 Foundations and Housekeeping Pads

Provide 3 inch high concrete foundations and housekeeping pads for the HVAC control system air compressors.

3.1.8 Control Drawings

Post laminated copies of as-built control system drawings in each mechanical room.

3.2 ADJUSTMENTS

Calibrate instrumentation and controls, and verify specified accuracy using test equipment traceable to National Institute for Science and Technology (NIST) standards. Adjust controls and equipment to maintain conditions indicated, to perform the functions indicated, and to operate in the sequence specified.

## 3.3 FIELD QUALITY CONTROL

a. Demonstrate compliance of HVAC control systems. Furnish personnel, equipment, instrumentation, and supplies necessary to perform calibration and site testing. Calibrate test equipment in accordance with NIST standards. Ensure that tests are performed or supervised by competent employees of the control system installer or the control system manufacturer regularly employed in testing and calibration of control systems.

b. Testing shall include field tests and the performance verification test. Field tests shall demonstrate proper calibration of instrumentation, input and output devices, and operation of specific equipment. The performance verification test shall ensure proper execution of sequence of operation and proper tuning of control loops.

C. Submit original copies of data produced, including results of each test procedure, to the Government at the conclusion of each phase of testing. Tests are subject to supervision and approval by Contracting Officer's Representative. Do not perform testing during scheduled seasonal off-periods of heating and cooling systems.

### 3.3.1 Test Reporting

After completion or termination of field tests and again after the performance verification test, identify, determine causes, replace, repair, or calibrate equipment which fails to meet the specification; and deliver a written report to the Contracting Officer. The report shall document test results, explain in detail the nature of each failure, and corrective action taken. After delivering the performance verification test report, the Contractor shall convene a test review meeting at the job site to present results and recommendations to the Contracting Officer. As a part of the test review meeting, the Contractor shall demonstrate by performing appropriate portions of field tests or the performance verification test that failures have been corrected. Based on Contractor's report and test review meeting, the Contracting Officer will determine either the restart point or successful completion of testing. Do not commence required retesting until after receipt of written notification by the Contracting Officer’s Representative. At the conclusion of retesting, repeat the assessment.

### 3.3.2 Contractor's Field Testing

Calibrate field equipment and verify equipment and system operation before system is placed on-line. Include the following tests in field testing.

#### 3.3.2.1 Tubing and Wiring Integrity Tests

Test tubing system pneumatically at 1.5 times the design working pressure for 24 hours. Allowable leakage rate is that which produces a pressure drop 1 psig in 24 hours with compressed air supply turned off. Test wiring for continuity, ground faults, and open and short circuits.

3.3.2.2 System Inspection

Observe HVAC control system in shutdown condition. Check dampers and valves for proper normal positions. Document positions for the performance verification test report.

3.3.2.3 Operation of Output Test

Check the operation of output to verify correct operation. Operate analog device to minimum range (e.g., 4 mA) and maximum range (e.g., 20 mA), and measure and record actual output values.

3.3.2.4 Actuator Range Adjustment

With the controller, apply a control signal to each actuator and verify that the actuator operates properly from its normal position through to the full range of stroke position. Record actual spring ranges and normal positions for modulating control valves and dampers.

3.3.3 Coordination With HVAC System Balancing

Tune the control system after air and hydronic systems have been balanced, minimum damper positions have been set, and a report has been issued.

3.3.4 Field Test Documentation

Before scheduling the performance verification test, provide field test documentation and written certification of completion to Contracting Officer, that the installed system has been calibrated, tested, and is ready to begin the performance verification test. Do not start the performance verification test prior to receiving written permission from the Contracting Officer.

3.3.5 Performance Verification Test

Conduct the performance verification tests to demonstrate that the control system maintains setpoints and that the control loops are tuned for the correct sequence of operation. Conduct the performance verification test during one week of continuous HVAC and control systems operation and before final acceptance of work. Specifically, the performance verification test shall demonstrate that the HVAC system operates properly through the complete sequence of operation (e.g., seasonal, occupied and unoccupied, warm up, etc.), for specified control sequences. Demonstrate proper control system response for abnormal conditions for which there is a specified system or controls response by simulating these conditions. Demonstrate that hardware interlocks and safety devices work as designed. Demonstrate that the control system performs the correct sequence of control.

3.4 TRAINING

Provide a qualified instructor to conduct training courses for designated personnel in maintenance and operation of HVAC and control systems. Orientate training to the specific

system being installed under the contract. Furnish audiovisual equipment and other training materials and supplies. A training day is defined as 8 hours of classroom or lab instruction, including two 15-minute breaks and excluding lunch time, Monday through Friday, during the daytime shift in effect at the training facility. For guidance, assume that the attendees have a high school education and are familiar with HVAC systems. Submit planned training schedule, agenda, and class materials to the Contracting Officer at least 45 days prior to training.

3.4.1 System Maintenance Training

Course shall be taught at the project site within one month after completion of endurance test for a period of 2 training days. Maximum of 2 personnel shall attend the course. Course shall include but not be limited to the following:

a. Physical layout for each piece of hardware

b. Troubleshooting and diagnostics procedures

c. Repair instructions

d. Preventive maintenance procedures and schedule

e. Calibration procedures

3.5 QUALIFIED SERVICE ORGANIZATION LIST

The qualified service organization list shall include names and telephone numbers of organizations qualified to service HVAC control systems.

3.6 COMMISSIONING

Commissioning of control systems is specified in the pre-field TAB engineering report described in Section 23 05 93 TESTING, ADJUSTING AND BALANCING.

-- End of Section 23 09 53 --

SECTION 23 23 00
REFRIGERANT PIPING

PART 1 GENERAL

1.1 REFERENCES

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

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

| | |
|---|---|
| AHRI 710 | (2009) Performance Rating of Liquid-Line Driers |

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

| | |
|---|---|
| ANSI/ASHRAE 15 & 34 | (2010; Addenda a, b, c, d, e, f, g, h, I, j, k, l, n and o; Errata 2011) ANSI/ASHRAE Standard 15-Safety Standard for Refrigeration Systems and ANSI/ASHRAE Standard 34-Designation and Safety Classification of Refrigerants |

AMERICAN WELDING SOCIETY (AWS)

| | |
|---|---|
| AWS A5.8/A5.8M | (2011) Specification for Filler Metals for Brazing and Braze Welding |
| AWS BRH | (2007) Brazing Handbook |

ASME INTERNATIONAL (ASME)

| | |
|---|---|
| ASME B16.22 | (2001; R 2010) Standard for Wrought Copper and Copper Alloy Solder Joint Pressure Fittings |
| ASME B16.26 | (2011) Standard for Cast Copper Alloy Fittings for Flared Copper Tubes |
| ASME B31.1 | (2012) Power Piping |
| ASME B31.5 | (2010) Refrigeration Piping and Heat Transfer Components |
| ASME BPVC SEC IX | (2010) BPVC Section IX-Welding and Brazing Qualifications |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A 53/A 53M | (2007) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless |
| ASTM A 653/A 653M | (2009a) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process |
| ASTM B 117 | (2009) Standing Practice for Operating Salt Spray (Fog) Apparatus |
| ASTM B 280 | (2008) Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service |
| ASTM B 32 | (2008) Standard Specification for Solder Metal |
| ASTM B 62 | (2009) Standard Specification for Composition Bronze or Ounce Metal Castings |
| ASTM B 75 | (2002) Standard Specification for Seamless Copper Tube |
| ASTM B 813 | (2000; R 2009) Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube |
| ASTM D 3308 | (2006) PTFE Resin Skived Tape |
| ASTM D 520 | (2000; R 2005) Zinc Dust Pigment |
| ASTM E 84 | (2010) Standard Test Method for Surface Burning Characteristics of Building Materials |

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

| | |
|---|---|
| MSS SP-58 | (2009) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation |
| MSS SP-69 | (2003; R 2004) Standard for Pipe Hangers and Supports - Selection and Application |

## 1.2 SUBMITTALS

Contracting Officer's written approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Refrigerant Piping System

Manufacturer's standard catalog data, at least 5 weeks prior to the purchase or installation of a particular component, highlighted to show material, size, options, performance charts and curves, etc. in adequate detail to demonstrate compliance with contract requirements. Include in the data manufacturer's recommended installation instructions and procedures. Provide data for the following components as a minimum:

a. Piping and Fittings

b. Valves

c. Piping Accessories

d. Pipe Hangers, Inserts, and Supports

## 1.3 QUALITY ASSURANCE

### 1.3.1 Qualifications

Piping shall be welded in accordance with the qualified procedures using performance qualified welders and welding operators. Procedures and welders shall be qualified in accordance with ASME BPVC SEC IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.1. Notify the Contracting Officer's Representative 24 hours in advance of tests to be performed at the work site, if practical. The welder or welding operator shall apply the personally assigned symbol near each weld made, as a permanent record.

### 1.3.2 Contract Drawings

Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories that may be required. Carefully investigate the plumbing, fire protection, electrical, structural and finish conditions that would affect the work to be performed and arrange such work accordingly, furnishing required offsets, fittings, and accessories to meet such conditions.

## 1.4 DELIVERY, STORAGE, AND HANDLING

Protect stored items from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Proper protection and care of all material both before and during installation is the Contractor's responsibility. Replace any materials found to be damaged at the Contractor's expense. During installation, cap piping and similar openings to keep out dirt and other foreign matter.

## 1.5 MAINTENANCE

### 1.5.1 General

Operation and maintenance data shall comply with the requirements of Section 01 78 23 OPERATING INSTRUCTIONS AND TRAINING and as specified herein.

# PART 2 PRODUCTS

## 2.1 STANDARD COMMERCIAL PRODUCTS

a. Provide materials and equipment which are standard products of a manufacturer regularly engaged in the manufacturing of such products, that are of a similar material, design and workmanship and that have been in satisfactory commercial or industrial use for 2 years prior to bid opening.

b. The 2 year use shall include applications of equipment and materials under similar circumstances and of similar size. The 2 years experience shall be satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturer's catalogs, or brochures. Products having less than a 2 year field service record will be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown.

c. Products shall be supported by a service organization. System components shall be environmentally suitable for the indicated locations.

## 2.2 REFRIGERANT PIPING SYSTEM

Refrigerant piping, valves, fittings, and accessories shall be in accordance with ANSI/ASHRAE 15 & 34 and ASME B31.5, except as specified herein. Refrigerant piping, valves, fittings, and accessories shall be compatible with the fluids used and capable of withstanding the pressures and temperatures of the service. Refrigerant piping, valves, and accessories used for refrigerant service shall be cleaned, dehydrated, and sealed (capped or plugged) prior to shipment from the manufacturer's plant.

## 2.3 PIPE, FITTINGS AND END CONNECTIONS (JOINTS)

### 2.3.1 Copper Tubing

Copper tubing shall conform to ASTM B 280 annealed or hard drawn as required. Copper tubing shall be soft annealed where bending is required and hard drawn where no bending is required. Soft annealed copper tubing shall not be used in sizes larger than 1-3/8 inches. Joints shall be brazed except that joints on lines 7/8 inch and smaller may be flared. Cast copper alloy fittings for flared copper tube shall conform to ASME B16.26 and ASTM B 62. Wrought copper and bronze solder-joint pressure fittings shall conform to ASME B16.22 and ASTM B 75. Joints and fittings for brazed joint shall be wrought-copper or forged-brass sweat fittings. Cast sweat-

type joints and fittings shall not be allowed for brazed joints. Brass or bronze adapters for brazed tubing may be used for connecting tubing to flanges and to threaded ends of valves and equipment.

2.3.2 Solder

Solder shall conform to ASTM B 32, grade Sb5, tin-antimony alloy for service pressures up to 150 psig. Solder flux shall be liquid or paste form, non-corrosive and conform to ASTM B 813.

2.3.3 Brazing Filler Metal

Filler metal shall conform to AWS A5.8/A5.8M, Type BAg-5 with AWS Type 3 flux, except Type BCuP-5 or BCuP-6 may be used for brazing copper-to-copper joints.

2.4 VALVES

Valves shall be designed, manufactured, and tested specifically for refrigerant service. Valve bodies shall be of brass, bronze, steel, or ductile iron construction. Valves 1 inch and smaller shall have brazed or socket welded connections. Threaded end connections shall not be used, except in pilot pressure or gauge lines where maintenance disassembly is required and welded flanges cannot be used. Internal parts shall be removable for inspection or replacement without applying heat or breaking pipe connections. Valve stems exposed to the atmosphere shall be stainless steel or corrosion resistant metal plated carbon steel. Direction of flow shall be legibly and permanently indicated on the valve body. Control valve inlets shall be fitted with integral or adapted strainer or filter where recommended or required by the manufacturer. Purge, charge and receiver valves shall be of manufacturer's standard configuration.

2.4.1 Refrigerant Stop Valves

Valve shall be the globe or full-port ball type with a back-seating stem especially packed for refrigerant service. Valve packing shall be replaceable under line pressure. Valve shall be provided with a wrench operator and a seal cap. Valve shall be the straight or angle pattern design as indicated.

2.4.2 Check Valves

Valve shall be the swing or lift type as required to provide positive shutoff at the differential pressure indicated. Valve shall be provide with resilient seat.

2.5 PIPING ACCESSORIES

2.5.1 Filter Driers

Driers shall conform to AHRI 710. Sizes 5/8 inch and larger shall be the full flow, replaceable core type. Sizes 1/2 inch and smaller shall be the sealed type. Cores shall be of suitable desiccant that will not plug, cake, dust, channel, or break down, and shall remove water, acid,

and foreign material from the refrigerant. Filter driers shall be constructed so that none of the desiccant will pass into the refrigerant lines. Minimum bursting pressure shall be 1,500 psi.

2.5.2 Pipe Hangers, Inserts, and Supports

Pipe hangers, inserts, guides, and supports shall conform to MSS SP-58 and MSS SP-69.

2.5.3 Escutcheons

Escutcheons shall be chromium-plated iron or chromium-plated brass, either one piece or split pattern, held in place by internal spring tension or set screws.

2.6 FABRICATION

2.6.1 Factory Coating

Unless otherwise specified, equipment and component items, when fabricated from ferrous metal, shall be factory finished with the manufacturer's standard finish, except that items located outside of buildings shall have weather resistant finishes that will withstand 125 hours exposure to the salt spray test specified in ASTM B 117 using a 5 percent sodium chloride solution. Immediately after completion of the test, the specimen shall show no signs of blistering, wrinkling, cracking, or loss of adhesion and no sign of rust creepage beyond 1/8 inch on either side of the scratch mark. Cut edges of galvanized surfaces where hot-dip galvanized sheet steel is used shall be coated with a zinc-rich coating conforming to ASTM D 520, Type I.

2.6.2 Factory Applied Insulation

Refrigerant suction lines between the cooler and each compressor shall be insulated with not less than 3/4 inch thick unicellular plastic foam. Factory insulated items installed outdoors are not required to be fire-rated. As a minimum, factory insulated items installed indoors shall have a flame spread index no higher than 75 and a smoke developed index no higher than 150. Factory insulated items (no jacket) installed indoors and which are located in air plenums, in ceiling spaces, and in attic spaces shall have a flame spread index no higher than 25 and a smoke developed index no higher than 50. Flame spread and smoke developed indexes shall be determined by ASTM E 84. Insulation shall be tested in the same density and installed thickness as the material to be used in the actual construction. Material supplied by a manufacturer with a jacket shall be tested as a composite material. Jackets, facings, and adhesives shall have a flame spread index no higher than 25 and a smoke developed index no higher than 50 when tested in accordance with ASTM E 84.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, perform a verification of dimensions in the field, and advise the Contracting Officer's Representative and Contracting Officer of any discrepancy before performing any work.

## 3.2 INSTALLATION

Pipe and fitting installation shall conform to the requirements of ASME B31.1. Pipe shall be cut accurately to measurements established at the jobsite, and worked into place without springing or forcing, completely clearing all windows, doors, and other openings. Cutting or other weakening of the building structure to facilitate piping installation will not be permitted without written approval. Pipe or tubing shall be cut square, shall have burrs removed by reaming, and shall permit free expansion and contraction without causing damage to the building structure, pipe, joints, or hangers.

### 3.2.1 Directional Changes

Changes in direction shall be made with fittings, except that bending of pipe 4 inches and smaller will be permitted, provided a pipe bender is used and wide weep bends are formed. Mitering or notching pipe or other similar construction to form elbows or tees will not be permitted. The centerline radius of bends shall not be less than 6 diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations will not be accepted.

### 3.2.2 Functional Requirements

Piping shall be installed 1/2 inch/10 feet of pipe in the direction of flow to ensure adequate oil drainage. Open ends of refrigerant lines or equipment shall be properly capped or plugged during installation to keep moisture, dirt, or other foreign material out of the system. Piping shall remain capped until installation. Equipment piping shall be in accordance with the equipment manufacturer's recommendations and the contract drawings. Equipment and piping arrangements shall fit into space allotted and allow adequate acceptable clearances for installation, replacement, entry, servicing, and maintenance.

### 3.2.3 Fittings and End Connections

#### 3.2.3.1 Threaded Connections

Threaded connections shall be made with tapered threads and made tight with PTFE tape complying with ASTM D 3308 or equivalent thread-joint compound applied to the male threads only. Not more than three threads shall show after the joint is made.

#### 3.2.3.2 Brazed Connections

Brazing shall be performed in accordance with AWS BRH, except as modified herein. During brazing, the pipe and fittings shall be filled with a pressure regulated inert gas, such as nitrogen, to prevent the formation of scale. Before brazing copper joints, both the outside of the tube and the inside of the fitting shall be cleaned with a wire fitting brush until the entire joint surface is

bright and clean. Brazing flux shall not be used. Surplus brazing material shall be removed at all joints. Steel tubing joints shall be made in accordance with the manufacturer's recommendations. Joints in steel tubing shall be painted with the same material as the baked-on coating within 8 hours after joints are made. Tubing shall be protected against oxidation during brazing by continuous purging of the inside of the piping using nitrogen. Piping shall be supported prior to brazing and not be sprung or forced.

3.2.4 Valves

3.2.4.1 General

Refrigerant stop valves shall be installed on each side of each piece of equipment such as compressors condensers, evaporators, receivers, and other similar items in multiple-unit installation, to provide partial system isolation as required for maintenance or repair. Stop valves shall be installed with stems horizontal unless otherwise indicated. Ball valves shall be installed with stems positioned to facilitate operation and maintenance. Isolating valves for pressure gauges and switches shall be external to thermal insulation. Safety switches shall not be fitted with isolation valves. Filter dryers having access ports may be considered a point of isolation. Purge valves shall be provided at all points of systems where accumulated noncondensable gases would prevent proper system operation. Valves shall be furnished to match line size, unless otherwise indicated or approved.

3.2.5 Filter Dryer

A liquid line filter dryer shall be provided on each refrigerant circuit located such that all liquid refrigerant passes through a filter dryer. Dryers shall be sized in accordance with the manufacturer's recommendations for the system in which it is installed. Dryers shall be installed such that it can be isolated from the system, the isolated portion of the system evacuated, and the filter dryer replaced. Dryers shall be installed in the horizontal position except replaceable core filter dryers may be installed in the vertical position with the access flange on the bottom.

3.2.6 Pipe Hangers, Inserts, and Supports

Pipe hangers, inserts, and supports shall conform to MSS SP-58 and MSS SP-69, except as modified herein. Pipe hanger types 5, 12, and 26 shall not be used. Hangers used to support piping 2 inches and larger shall be fabricated to permit adequate adjustment after erection while still supporting the load. Piping subjected to vertical movement, when operating temperatures exceed ambient temperatures, shall be supported by variable spring hangers and supports or by constant support hangers.

3.2.6.1 Hangers

Type 3 shall not be used on insulated piping. Type 24 may be used only on trapeze hanger systems or on fabricated frames.

3.2.6.2 Inserts

Type 18 inserts shall be secured to concrete forms before concrete is placed. Continuous inserts which allow more adjustments may be used if they otherwise meet the requirements for Type 18 inserts.

3.2.6.3 C-Clamps

Type 19 and 23 C-clamps shall be torqued in accordance with MSS SP-69 and have both locknuts and retaining devices, furnished by the manufacturer. Field-fabricated C-clamp bodies or retaining devices are not acceptable.

3.2.6.4 Angle Attachments

Type 20 attachments used on angles and channels shall be furnished with an added malleable-iron heel plate or adapter.

3.2.6.5 Saddles and Shields

Where Type 39 saddle or Type 40 shield are permitted for a particular pipe attachment application, the Type 39 saddle, connected to the pipe, shall be used on all pipe 4 inches and larger when the temperature of the medium is 60 degrees F or higher. Type 40 shields shall be used on all piping less than 4 inches and all piping 4 inches and larger carrying medium less than 60 degrees F. A high density insulation insert of cellular glass shall be used under the Type 40 shield for piping 2 inches and larger.

3.2.6.6 Horizontal Pipe Supports

Horizontal pipe supports shall be spaced as specified in MSS SP-69 and a support shall be installed not over 1 foot from the pipe fitting joint at each change in direction of the piping. Pipe supports shall be spaced not over 5 feet apart at valves. Pipe hanger loads suspended from steel joist with hanger loads between panel points in excess of 50 pounds shall have the excess hanger loads suspended from panel points.

3.2.6.7 Vertical Pipe Supports

Vertical pipe shall be supported at each floor, except at slab-on-grade, and at intervals of not more than 15 feet not more than 8 feet from end of risers, and at vent terminations.

3.2.6.8 Pipe Guides

Type 35 guides using, steel, reinforced polytetrafluoroethylene (PTFE) or graphite slides shall be provided where required to allow longitudinal pipe movement. Lateral restraints shall be provided as required. Slide materials shall be suitable for the system operating temperatures, atmospheric conditions, and bearing loads encountered.

3.2.6.9 Steel Slides

Where steel slides do not require provisions for restraint of lateral movement, an alternate guide method may be used. On piping 4 inches and larger, a Type 39 saddle shall be used. On piping under 4 inches, a Type 40 protection shield may be attached to the pipe or insulation and freely rest on a steel slide plate.

3.2.6.10 High Temperature Guides with Cradles

Where there are high system temperatures and welding to piping is not desirable, then the Type 35 guide shall include a pipe cradle, welded to the guide structure and strapped securely to the pipe. The pipe shall be separated from the slide material by at least 4 inches, or by an amount adequate for the insulation, whichever is greater.

3.2.6.11 Multiple Pipe Runs

In the support of multiple pipe runs on a common base member, a clip or clamp shall be used where each pipe crosses the base support member. Spacing of the base support members shall not exceed the hanger and support spacing required for an individual pipe in the multiple pipe run.

3.2.6.12 Structural Attachments

Attachment to building structure concrete and masonry shall be by cast-in concrete inserts, built-in anchors, or masonry anchor devices. Inserts and anchors shall be applied with a safety factor not less than 5. Supports shall not be attached to metal decking. Masonry anchors for overhead applications shall be constructed of ferrous materials only. Structural steel brackets required to support piping, headers, and equipment, but not shown, shall be provided under this section.

3.2.7 Pipe Alignment Guides

Pipe alignment guides shall be provided where indicated for expansion loops, offsets, and bends and as recommended by the manufacturer for expansion joints, not to exceed 5 feet on each side of each expansion joint, and in lines 4 inches or smaller not more than 2 feet on each side of the joint.

3.2.8 Pipe Anchors

Anchors shall be provided wherever necessary or indicated to localize expansion or to prevent undue strain on piping. Anchors shall consist of heavy steel collars with lugs and bolts for clamping and attaching anchor braces, unless otherwise indicated. Anchor braces shall be installed in the most effective manner to secure the desired results using turnbuckles where required. Supports, anchors, or stays shall not be attached where they will injure the structure or adjacent construction during installation or by the weight of expansion of the pipeline. Where pipe and conduit penetrations of vapor barrier sealed surfaces occur, these items shall be anchored immediately adjacent to each penetrated surface, to provide essentially zero movement

within penetration seal. Detailed drawings of pipe anchors shall be submitted for approval before installation.

3.2.9 Building Surface Penetrations

Sleeves shall not be installed in structural members except where indicated or approved. Sleeves in nonload bearing surfaces shall be galvanized sheet metal, conforming to ASTM A 653/A 653M, Coating Class G-90, 20 gauge. Sleeves in load bearing surfaces shall be uncoated carbon steel pipe, conforming to ASTM A 53/A 53M, Schedule 30 Standard weight. Sealants shall be applied to moisture and oil-free surfaces and elastomers to not less than 1/2 inch depth. Sleeves shall not be installed in structural members.

3.2.9.1 General Service Areas

Each sleeve shall extend through its respective wall, floor, or roof, and shall be cut flush with each surface. Pipes passing through concrete or masonry wall or concrete floors or roofs shall be provided with pipe sleeves fitted into place at the time of construction. Sleeves shall be of such size as to provide a minimum of 1/4 inch all-around clearance between bare pipe and sleeves or between jacketed-insulation and sleeves. Except in pipe chases or interior walls, the annular space between pipe and sleeve or between jacket over-insulation and sleeve shall be sealed in accordance with Section 07 92 00 JOINT SEALANTS.

3.2.9.2 Escutcheons

Finished surfaces where exposed piping, bare or insulated, pass through floors, walls, or ceilings, except in boiler, utility, or equipment rooms, shall be provided with escutcheons. Where sleeves project slightly from floors, special deep-type escutcheons shall be used. Escutcheon shall be secured to pipe or pipe covering.

3.3 CLEANING AND ADJUSTING

Clean uncontaminated system(s) by evacuation and purging procedures currently recommended by refrigerant and refrigerant equipment manufacturers, and as specified herein, to remove small amounts of air and moisture. Systems containing moderate amounts of air, moisture, contaminated refrigerant, or any foreign matter shall be considered contaminated systems. Restoring contaminated systems to clean condition including disassembly, component replacement, evacuation, flushing, purging, and re-charging, shall be performed using currently approved refrigerant and refrigeration manufacturer's procedures. Restoring contaminated systems shall be at no additional cost to the Government as determined by the Contracting Officer's Representative. Water shall not be used in any procedure or test.

3.4 REFRIGERANT PIPING TESTS

After all components of the refrigerant system have been installed and connected, subject the entire refrigeration system to pneumatic, evacuation, and startup tests as described herein. Conduct tests in the presence of the Contracting Officer's Representative. Water and electricity

required for the tests will be furnished by the Government. Provide all material, equipment, instruments, and personnel required for the test. Provide the services of a qualified technician, as required, to perform all tests and procedures indicated herein. Field tests shall be coordinated with Section 23 05 93 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS.

3.4.1 Preliminary Procedures

Prior to pneumatic testing, equipment which has been factory tested and refrigerant charged as well as equipment which could be damaged or cause personnel injury by imposed test pressure, positive or negative, shall be isolated from the test pressure or removed from the system. Safety relief valves and rupture discs, where not part of factory sealed systems, shall be removed and openings capped or plugged.

3.4.2 Pneumatic Test

Pressure control and excess pressure protection shall be provided at the source of test pressure. Valves shall be wide open, except those leading to the atmosphere. Test gas shall be dry nitrogen, with minus 70 degree F dewpoint and less than 5 ppm oil. Test pressure shall be applied in two stages before any refrigerant pipe is insulated or covered. First stage test shall be at 10 psi with every joint being tested with a thick soap or color indicating solution. Second stage tests shall raise the system to the minimum refrigerant leakage test pressure specified in ANSI/ASHRAE 15 & 34 with a maximum test pressure 25 percent greater. Pressure above 100 psig shall be raised in 10 percent increments with a pressure acclimatizing period between increments. The initial test pressure shall be recorded along with the ambient temperature to which the system is exposed. Final test pressures of the second stage shall be maintained on the system for a minimum of 24 hours. At the end of the 24 hour period, the system pressure will be recorded along with the ambient temperature to which the system is exposed. A correction factor of 0.3 psi will be allowed for each degree F change between test space initial and final ambient temperature, plus for increase and minus for a decrease. If the corrected system pressure is not exactly equal to the initial system test pressure, then the system shall be investigated for leaking joints. To repair leaks, the joint shall be taken apart, thoroughly cleaned, and reconstructed as a new joint. Joints repaired by caulking, remelting, or back-welding/brazing shall not be acceptable. Following repair, the entire system shall be retested using the pneumatic tests described above. The entire system shall be reassembled once the pneumatic tests are satisfactorily completed.

3.4.3 Evacuation Test

Following satisfactory completion of the pneumatic tests, the pressure shall be relieved and the entire system shall be evacuated to an absolute pressure of 300 micrometers. During evacuation of the system, the ambient temperature shall be higher than 35 degrees F. No more than one system shall be evacuated at one time by one vacuum pump. Once the desired vacuum has been reached, the vacuum line shall be closed and the system shall stand for 1 hour. If the pressure rises over 500 micrometers after the 1 hour period, then the system shall be evacuated again down to 300 micrometers and let set for another 1 hour period. The system shall not be charged until a vacuum of at least 500 micrometers is maintained for a period of 1 hour without the

assistance of a vacuum line. If during the testing the pressure continues to rise, check the system for leaks, repair as required, and repeat the evacuation procedure. During evacuation, pressures shall be recorded by a thermocouple-type, electronic-type, or a calibrated-micrometer type gauge.

3.4.4 System Charging and Startup Test

Following satisfactory completion of the evacuation tests, the system shall be charged with the required amount of refrigerant by raising pressure to normal operating pressure and in accordance with manufacturer's procedures. Following charging, the system shall operate with high-side and low-side pressures and corresponding refrigerant temperatures, at design or improved values. The entire system shall be tested for leaks. Fluorocarbon systems shall be tested with halide torch or electronic leak detectors.

3.4.5 Refrigerant Leakage

If a refrigerant leak is discovered after the system has been charged, the leaking portion of the system shall immediately be isolated from the remainder of the system and the refrigerant pumped into the system receiver or other suitable container. Under no circumstances shall the refrigerant be discharged into the atmosphere.

3.4.6 Contractor's Responsibility

At all times during the installation and testing of the refrigeration system, take steps to prevent the release of refrigerants into the atmosphere. The steps shall include, but not be limited to, procedures which will minimize the release of refrigerants to the atmosphere and the use of refrigerant recovery devices to remove refrigerant from the system and store the refrigerant for reuse or reclaim. At no time shall more than 3 ounces of refrigerant be released to the atmosphere in any one occurrence. Any system leaks within the first year shall be repaired in accordance with the requirements herein at no cost to the Government including material, labor, and refrigerant if the leak is the result of defective equipment, material, or installation.

-- End of Section 23 23 00 --

SECTION 23 31 13
METAL DUCTS

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

| | |
|---|---|
| AISC 325 | (2011) Steel Construction Manual |
| ANSI/AISC 360 | (2010) Specification for Structural Steel Buildings |

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

| | |
|---|---|
| ASHRAE EQUIP IP HDBK | (2008) Handbook, HVAC Systems and Equipment (IP Edition) |
| ASHRAE FUN IP | (2013) Fundamentals Handbook, I-P Edition |

AMERICAN WELDING SOCIETY (AWS)

| | |
|---|---|
| AWS A5.8/A5.8M | (2011) Specification for Filler Metals for Brazing and Braze Welding |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A 123/A 123M | (2009) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products |
| ASTM A 36/A 36M | (2008) Standard Specification for Carbon Structural Steel |
| ASTM A 653/A 653M | (2009a) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process |
| ASTM A 924/A 924M | (2010) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 90A | (2012) Standard for the Installation of Air Conditioning and Ventilating Systems |

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

| | |
|---|---|
| SMACNA 1966 | (2005) HVAC Duct Construction Standards Metal and Flexible, 3rd Edition |
| SMACNA 1987 | (2006) HVAC Duct Systems Inspection Guide, 3rd Edition |

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

| | |
|---|---|
| SAE AMS 2480 | (2009) Phosphate Treatment, Paint, Base |

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

| | |
|---|---|
| SSPC Painting Manual | (2002) Good Painting Practice, Steel Structures Painting Manual, Volume 1, Edition 4 |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 181 | (2005; R 2005 thru 2008) Standard for Factory-Made Air Ducts and Air Connectors |

1.2 DESIGN REQUIREMENTS

A. Section 23 00 00 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEMS apply to work specified in this section.

B. Submit Equipment and Performance Data for medium/high pressure ductwork systems consisting of use life, system functional flows, safety features, and mechanical automated details. Submit test response and performance characteristics curves for certified equipment.

1.3 SCOPE OF WORK

A. Encompass low-pressure systems ductwork and plenums where maximum air velocity is 2,000 feet per minute (fpm) and maximum static pressure is 2 inches water gage (wg), positive or negative.

B. Submit Connection Diagrams for low pressure ductwork systems indicating the relation and connection of devices and apparatus by showing the general physical layout of all controls, the interconnection of one system (or portion of system) with another, and internal tubing, wiring, and other devices.

C. Encompass high velocity systems ductwork where:

1. Minimum air velocity exceeds 2,000 feet per minute (fpm) or static pressure exceeds 2 inches water gage (wg).

2. Medium static pressure ranges from over 2 inches wg through 3 inches wg, positive or negative, or over 3 inches wg through 6 inches wg positive.

3. Do not use rigid fibrous-glass ductwork.

## 1.4 SUBMITTALS

Contracting Officer's written approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Submit the following in accordance with paragraph entitled, "Drawings," of this section.

Connection Diagrams
Record Drawings

SD-03 Product Data

Submit Equipment and Performance Data for medium/high pressure ductwork systems in accordance with paragraph entitled, "Design Requirements," of this section.

Submit manufacturer's catalog data for the following items:

Galvanized Steel Ductwork Materials
Brazing Materials
Mill-Rolled Reinforcing and Supporting Materials
Round Sheet Metal Duct Fittings
Turning Vanes
Flexible Connectors
Flexible Duct Materials
Flexible Connectors
Gravity Backdraft and Relief Dampers
Manual Volume Dampers

SD-06 Test Reports

Submit test reports for medium/high pressure ductwork systems in accordance with the paragraphs entitled, "Ductwork Leakage Tests" and "Fire Damper Tests," of this section.

Ductwork Leakage Tests

1.5 GENERAL REQUIREMENTS

Include the manufacturer's style or catalog numbers, specification and drawing reference numbers, warranty information, and fabrication site information within Material, Equipment, and Fixture Lists.

1.6 DRAWINGS

A. Submit Connection Diagrams for medium/high pressure ductwork systems indicating the relation and connection of devices and apparatus by showing the general physical layout of all controls, the interconnection of one system (or portion of system) with another, and internal tubing, wiring, and other devices.

B. Provide Record Drawings with current factual information including deviations from, and amendments to, the drawings and concealed or visible changes in the work, for medium/high pressure ductwork systems. Label drawings "As-Built".

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Galvanized Steel Ductwork Materials

A. Galvanized steel ductwork sheet metal shall be carbon steel, of lock-forming quality, hot-dip galvanized, with regular spangle-type zinc coating, conforming to ASTM A 924/A 924M and ASTM A 653/A 653M, Designation G90. Treat duct surfaces to be painted by phosphatizing.

B. Conform to ASHRAE EQUIP IP HDBK, Chapter 16, ASHRAE FUN IP, Chapter 32 and SMACNA 1966 for sheet metal gages and reinforcement thickness.

C. Low pressure ductwork minimum standards are as follows:

MINIMUM SHEET METAL GAGE

| DUCT WIDTH INCHES | GAGE |
|---|---|
| 0 – 12 | 26 |
| 13 – 30 | 24 |
| 31 – 60 | 22 |

2.1.2 Brazing Materials

Brazing materials shall be silicon bronze conforming to AWS A5.8/A5.8M.

2.1.3 Mill-Rolled Reinforcing And Supporting Materials

A. Conform to ASTM A 36/A 36Mfor mill-rolled structural steel and, wherever in contact with sheet metal ducting galvanize to commercial weight of zinc or coated with materials conforming to ASTM A 123/A 123M and SSPC Painting Manual.

B. Equivalent strength, proprietary design, rolled-steel structural support systems may be submitted for approval in lieu of mill-rolled structural steel.

2.2 COMPONENTS

2.2.1 Round Sheet Metal Duct Fittings

A. Shop fabricate fittings.

B. Manufacture as separate fittings, not as tap collars welded or brazed into duct sections.

C. Submit for approval offset configurations.

D. Miter elbows shall be two-piece type for angles less than 31 degrees, three-piece type for angles 31 through 60 degrees, and five-piece type for angles 61 through 90 degrees. Centerline radius of elbows shall be 1-1/2 times fitting cross section diameter.

E. Crosses, increasers, reducers, reducing tees, and 90-degree tees shall be conical type.

F. Cutouts in fitting body shall be equal to branch tap dimension or, where smaller, excess material shall be flared and rolled into smooth radius nozzle configuration.

2.2.2 Reinforcement

Support inner liners of both duct and fittings by metal spacers welded in position to maintain spacing and concentricity.

2.2.3 Fittings

A. Make divided flow fittings as separate fittings, not tap collars into duct sections, with the following construction requirements:

1. Sound, airtight, continuous welds at intersection of fitting body and tap

2. Tap liner securely welded to inner liner, with weld spacing not to exceed 3 inches

3. Pack insulation around the branch tap area for complete cavity filling.

4. Carefully fit branch connection to cutout openings in inner liner without spaces for air erosion of insulation and without sharp projections that cause noise and airflow disturbance.

B. Continuously braze seams in the pressure shell of fittings. Protect galvanized areas that have been damaged by welding with manufacturer's standard corrosion-resistant coating.

C. Submit for approval offset configurations.

D. Elbows shall be two-piece type for angles through 35 degrees, three-piece type for angles 36 through 71 degrees, and five-piece type for angles 72 through 90 degrees.

E. Crosses, increasers, reducers, reducing tees, and 90-degree tees shall be conical type.

2.2.4 Turning Vanes

Turning vanes shall be double-wall type, commercially manufactured for high-velocity system service.

2.2.5 Dampers

Low pressure drop, high-velocity manual volume dampers, and high-velocity fire dampers shall be constructed in accordance with ASHRAE EQUIP IP HDBK, Chapter 16, ASHRAE FUN IP, Chapter 32 and SMACNA 1966.

2.2.6 Flexible Connectors For Sheet Metal

Connectors shall be UL listed, 30-ounce per square foot, waterproof, fire-retardant, airtight, woven fibrous-glass cloth, double coated with chloroprene. Clear width, not including clamping section, shall be 6 to 8 inches.

2.2.7 Duct Hangers

Duct hangers in contact with galvanized duct surfaces shall be galvanized steel painted with inorganic zinc.

2.2.8 Mill-Rolled Reinforcing And Supporting Materials

A. Mill-rolled structural steel shall conform to ASTM A 36/A 36M and, whenever in contact with sheet metal ducting, shall be galvanized in accordance with ASTM A 123/A 123M.

B. Equivalent strength, proprietary-design, rolled-steel structural support systems may be submitted for approval in lieu of mill-rolled structural steel.

2.2.9 Flexible Duct Materials

A. Flexible duct connectors shall be in accordance with UL 181, Class 1 material and shall comply with NFPA 90A.

B. Metal duct shall be bendable through 180 degrees without damage, with an inside bend radius not greater than one-half the diameter of duct. Metal shall be aluminum zinc-coated ASTM A 123/A 123M.

C. Wire-reinforced fibrous-glass duct shall consist of a minimum 1 pound/cubic foot density fibrous glass bonded to and supported by corrosion-protected spring helix. Vapor barrier shall be a 4 mil minimum, pigmented polyvinylchloride film. Duct shall be bendable without damage through 180 degrees with an inside bend radius not greater than two duct diameters. Minimum wall thickness shall be 1 inch. Thermal conductivity shall be not greater than 0.23 Btu per hour per square foot per degrees F at 75 degrees F mean. Permeance shall be not greater than 0.10 perm. Working pressure range shall be from minus 1/2 inch wg to plus 1-1/2 inches wg. Working temperature shall range from minus 20 to plus 250 degrees F. Minimum sustained velocity without delamination shall be 2,400 fpm. Materials shall conform to NFPA 90A. Provide flexible round duct length that does not exceed five feet.

2.2.10 Manual Volume Dampers

A. Conform to SMACNA 1966 for volume damper construction.

B. Equip dampers with an indicating quadrant regulator with a locking feature externally located and easily accessible for adjustment and standoff brackets to allow mounting outside external insulation. Where damper rod lengths exceed 30 inches, provide a regulator at each end of damper shaft.

C. All damper shafts shall have two-end bearings.

D. Splitter damper shall be 22-gage sheet metal. Hinges shall be full length piano-type.

E. Damper shaft shall be full length and shall extend beyond damper blade. A 3/8 inch square shaft shall be used for damper lengths up to 20 inches and a 1/2 inch square shaft shall be used for damper lengths 20 inches and larger. Where necessary to prevent damper vibration or slippage, adjustable support rods with locking provisions external to duct shall be provided at damper blade end.

F. Dampers in ducts having a width perpendicular to the axis of the damper that is greater than 12 inches shall be multiblade type having a substantial frame with blades fabricated of 16-gage metal. Blades shall not exceed 10 inches in width and 48 inches in length and shall be pinned to 1/2 inch diameter shafts. Dampers greater than 48 inches in width shall be made in two or more sections with intermediate mullions, each section being mechanically interlocked with the adjoining section or sections. Blades shall have graphite-impregnated nylon bearings and shall be connected so that adjoining blades rotate in opposite directions.

2.2.11 Gravity Backdraft And Relief Dampers

A. Frame shall be constructed of not less than 1-1/2- by 4 inch reinforced 16-gage galvanized carbon steel. Frames and mullions shall be solidly secured in place and sealed with elastomer calking against air bypass.

B. Maximum blade width shall be 9 inches, and maximum blade length shall be 36 inches. Blade material shall be 16-gage galvanized steel. Blades shall be provided with mechanically retained seals and 90-degree limit stops.

C. Dampers used for relief service shall have blades linked together to open not less than 30 degrees on 0.05 inch wg differential pressure.

D. Shaft bearings shall be graphite-impregnated nylon.

E. Counterbalanced dampers shall be equipped with fixed or adjustable counterbalancing weights.

F. Gravity backdraft dampers in sizes 18 by 18 inches or smaller, when furnished integral with air moving equipment, may be equipment manufacturer's standard construction.

PART 3 EXECUTION

3.1 PREPARATION

A. Provide sheet metal construction in accordance with the recommendations for best practices in ASHRAE EQUIP IP HDBK, Chapter 16, SMACNA 1966, NFPA 90A, and ASHRAE FUN IP, Chapter 32.

B. Where construction methods for certain items are not described in the referenced standards or herein, perform the work in accordance with recommendations for best practice defined in ASHRAE EQUIP IP HDBK.

C. Clean free of oil, grease, and deleterious substances sheet metal surfaces to be painted and surfaces to which adhesives are to be applied.

D. Duct strength shall be adequate to prevent failure under service pressure or vacuum created by fast closure of duct devices. Provide leaktight, automatic relief devices.

E. Supplementary steel shall be designed and fabricated in accordance with ANSI/AISC 360 and AISC 325.

3.2 INSTALLATION

A. Within Listing of Product Installations for medium/high pressure ductwork systems include identification of at least 5 units, similar to those proposed for use, that have been in successful

service for a minimum period of 5 years. Include purchaser, address of installation, service organization, and date of installation.

B. Fabricate airtight and include reinforcements, bracing, supports, framing, gasketing, sealing, and fastening to provide rigid construction and freedom from vibration, airflow-induced motion and noise, and excessive deflection at specified maximum system air pressure and velocity.

C. Enclose dampers located behind architectural intake or exhaust louvers by a rigid sheet metal collar and sealed to building construction with elastomers for complete air tightness.

D. Provide outside air-intake ducts and plenums made from sheet metal with soldered watertight joints.

E. Provide offsets and transformations as required to avoid interference with the building construction, piping, or equipment.

F. Wherever ducts pass through firewalls or through walls or floors dividing conditioned spaces from unconditioned spaces, provide a flanged segment in that surface during surface construction.

G. Clean free of oil, grease, and deleterious substances sheet metal surfaces to be painted or surfaces to which adhesives will be applied.

H. Where interiors of ducting may be viewed through air diffusion devices, construct the viewed interior with sheet metal and paint flat black.

I. Make plenum anchorage provisions, sheet metal joints, and other areas airtight and watertight by calking mating galvanized steel and concrete surfaces with a two-component elastomer.

## 3.3 APPLICATION

### 3.3.1 Low Pressure Sheet Metal Ducts

A. Weld angle iron frames at corners and ends, whenever possible. Angle iron reinforcements shall be riveted or welded to ducts not more than 6 inches on center, with not less than two points of attachment. Spot welding, where used, shall be 3 inches on center.

B. Standard seam joints shall be sealed with an elastomer compound to comply with SMACNA 1966 Seal Class A, B or C as applicable.

C. Crossbreaking shall be limited to 4 feet and shall be provided on all ducts 8 inches wide and wider. Bead reinforcement shall be provided in lieu of crossbreaking where panel popping may occur. Where rigid insulation will be applied, crossbreaking is not required.

#### 3.3.1.1 Longitudinal Duct Seams

Corner seams shall be Pittsburg lock.

3.3.1.2 Joints and Gaskets

Companion angle flanges shall be bolted together with 1/4 inch diameter bolts and nuts spaced 6 inches on center. Flanged joints shall be gasketed with chloroprene full-face gaskets 1/8 inch thick, with Shore A 40 durometer hardness. Gaskets shall be one piece and vulcanized at joints.

3.3.1.3 Flexible Duct Joints

Joints between flexible duct without sheet metal collars and round metal ductwork connections shall be made by trimming the ends, coating the inside of the flexible duct for a distance equal to depth of insertion with elastomer calk, and by securing with sheet metal screws or binding with a strap clamp.

3.3.1.4 Square Elbows

Provide single-vane duct turns in accordance with SMACNA 1966, and may be used on ducts 12 inches wide and narrower.

3.3.1.5 Radius Elbows

A. Conform to SMACNA 1966 for radius elbows. Provide an inside radius equal to the width of the duct. Where installation conditions preclude use of standard elbows, the inside radius may be reduced to a minimum of 0.25 times duct width and install turning vanes in accordance with the following schedule.

| WIDTH OF ELBOWS | RADIUS OF TURNING VANES IN PERCENT OF DUCT WIDTH | | |
|---|---|---|---|
| INCHES | VANE NO. 1 | VANE NO. 2 | VANE NO. 3 |
| Up to 16 | 56 | -- | -- |
| 17 to 48 | 43 | 73 | -- |
| 49 and over | 37 | 55 | 83 |

B. Where two elbows are placed together in the same plane in ducts 30 inches wide and larger, the guide vanes shall be continuous through both elbows rather than spaced in accordance with above schedule.

3.3.1.6 Outlets, Inlets, And Duct Branches

A. Install branches, inlets, and outlets so that air turbulence will be reduced to a minimum and air volume properly apportioned. Install adjustable splitter dampers at all supply junctions to permit adjustment of the amount of air entering the branch. Wherever an air-diffusion device is

shown as being installed on the side, top, or bottom of a duct, and whenever a branch takeoff is not of the splitter type, a commercially manufactured 45 degree side-take-off (STO) fitting with manual; provide volume damper to allow adjustment of the air quantity and to provide an even flow of air across the device or duct it services.

B. Where a duct branch is to handle more than 25 percent of the air handled by the duct main, use a complete 90-degree increasing elbow with an inside radius of 0.75 times branch duct width. Size of the leading end of the increasing elbow within the main duct shall have the same ratio to the main duct size as the ratio of the related air quantities handled.

C. Where a duct branch is to handle 25 percent or less of the air handled by the duct main, the branch connection shall have a 45 degree side take-off entry in accordance with SMACNA 1966.

3.3.1.7 Duct Transitions

A. Where the shape of a duct changes, the angle of the side of the transition piece shall not exceed 15 degrees from the straight run of duct connected thereto.

B. Where equipment is installed in ductwork, the angle of the side of the transition piece from the straight run of duct connected thereto shall not exceed 15 degrees on the upstream side of the equipment and 22-1/2 degrees on the downstream side of the equipment.

3.3.1.8 Branch Connections

Construct radius tap-ins in accordance with SMACNA 1966.

3.3.1.9 Access Openings

A. Install access doors and panels in ductwork adjacent to fire dampers at controls or at any item requiring periodic inspection, adjustment, maintenance, or cleaning, and every 20 feet 6.1M for indoor air quality housekeeping purposes.

B. Minimum size of access opening shall be 12 by 18 inches, unless precluded by duct dimensions or otherwise indicated.

C. Construct access door in accordance with SMACNA 1966, except that sliding doors may be used only for special conditions upon prior approval. Insulated doors shall be double-panel type.

D. Access doors that leak shall be made airtight by adding or replacing hinges and latches or by construction of new doors adequately reinforced, hinged, and latched.

3.3.1.10 Plenum Construction

A. Intake and discharge plenum shall have companion angle joints with the following minimum thickness of materials:

| LONGEST ANGLES SIDE INCHES | SHEET METAL USS GAGE ALL SIDES | COMPANION ANGLES INCHES | REINFORCEMENT INCHES, 24 INCHES ON CENTER MAXIMUM |
|---|---|---|---|
| To 48 | 20 | 1-1/2 by 1-1/2 by 1/8 | 1-1/2 by 1-1/2 by 1/8 |
| 49 to 84 | 18 | 2 by 2 by 1/8 | 2 by 2 by 3/16 |
| 85 to 120 | 16 | 2 by 2 by 1/8 | 2 by 2 by 1/8 |
| 121 and larger | 14 | 2 by 2 by 3/16 | 2 by 2 by 3/16 |

B. At the floor line and other points where plenums join masonry construction, panels shall be bolted 12 inches on center to 2- by 2- by 3/16 inch thick hot-dip galvanized steel angle that has been secured to the masonry with masonry anchors and bolts 24 inches on center and calked tight to the masonry.

C. Panels shall be anchored to curbing by not less than 2- by 2- by 3/16 inch thick hot-dip galvanized steel angle iron. Concrete curbing shall include angle iron nosing with welded studs for the anchoring of panels. Nosing shall be level at curb height within plus or minus 1/16 inch.

D. Plenum access doors shall be constructed in accordance with SMACNA 1966except that access doors smaller than man-access doors shall have door openings framed with angle iron that is one commercial size smaller than specified panel reinforcement.

E. Man-access door size shall be per SMACNA 1966 and paragraph entitled, "Access Openings," of this section. Insulated and uninsulated construction shall be per SMACNA 1966. Door openings shall be framed with channel iron. Doors shall be framed with angle iron. Channel iron and angle iron shall be approximately the same size as specified panel reinforcement. Exterior door skin shall be 16 gage. Latches shall be fabricated steel, hinges shall be at least 4 inches long, and bolting shall be at least 3/8 inch diameter.

F. Angle iron and channel iron shall have welded and ground miter corners.

3.3.1.11 Manual Volume Dampers

A. Balancing dampers of the splitter, butterfly, or multilouver type, shall be provided to balance each respective main and branch duct.

B. Dampers regulated through ceilings shall have regulator concealed in box mounted in the ceiling, with a cover finish aesthetically compatible with ceiling surface. Where ceiling is of removable construction, regulators shall be above ceiling, and location shall be marked on ceiling in a manner acceptable to the Contracting Officer's Representative.

3.3.1.12 Flexible Connectors For Sheet Metal

A. Air handling equipment, ducts crossing building expansion joints, and fan inlets and outlets shall be connected to upstream and downstream components by treated woven-cloth connectors.

B. Connectors shall be installed only after system fans are operative, and vibration isolation mountings have been adjusted. When system fans are operating, connectors shall be free of wrinkle caused by misalignment or fan reaction. Width of surface shall be curvilinear.

3.3.2 Rectangular Sheet Metal Ducts

3.3.2.1 Medium-Pressure Gages, Joints, And Reinforcement

A. Minimum sheet metal gages, joints, and reinforcements between joints shall be in accordance with ASHRAE EQUIP IP HDBK, Chapter 16, ASHRAE FUN IP, Chapter 32 and SMACNA 1966.

B. Sheet metal minimum thickness, transverse reinforcement between joints, and joints of ducts shall be in accordance with the following:

| LONGEST SIDE INCHES | SHEET METAL GAGE ALL SIDES | COMPANION ANGLE INCHES | REINFORCEMENT ANGLES INCHES, 24 INCHES ON CENTER MAXIMUM (BACK TO BACK) |
|---|---|---|---|
| 97 to 108 | 16 | 2 by 2 by 1/8, two tie rods along angle | Two 2 by 2 by 1/8, two tie rods along angle |
| 109 to 132 | 16 | 2 by 2 by 3/16, two tie rods along angle | Two 2 by 2 by 3/16, two tie rods along angle |
| 133 and longer | 14 | 2 by 2 by 3/16, with tie rods every 48 inches | Two 2 by 2 by 3/16, with tie rods every 48 inches |

3.3.2.2 Medium- And High-Pressure Branches, Inlets, Outlets

A. Install branches, inlets, and outlets to minimize air turbulence and to ensure proper airflow.

B. Install dampers so that the amount of air entering duct mains can be adjusted.

C. Provide commercially manufactured air extractors to allow adjustment of the air quantity and to provide an even flow of air across the device or duct served.

D. Where a duct branch is to handle over 25 percent of the air handled by the duct main, a complete 90-degree increasing elbow shall be used, with an inside radius of 0.75 times duct branch width. Size of the trailing end of the increasing elbow within the main duct shall be in the same ratio to the main duct size as the ratio of the relative air quantities handled.

E. Where a duct branch is to handle 25 percent or less of the air handled by the duct main, the branch connection shall have an inside radius of 0.75 times branch duct width, a minimum arc length of 45 degrees, and an outside radius of 1.75 times duct branch width. Arc shall be tangent to duct main.

3.3.2.3 High-Pressure Gages, Joints, And Reinforcement

A. Sheet metal minimum thickness, joints, and reinforcement between joints shall be in accordance with ASHRAE EQUIP IP HDBK, Chapter 16, ASHRAE FUN IP, Chapter 32 and SMACNA 1966.

B. The following types of ASHRAE EQUIP IP HDBK, Chapter 16, ASHRAE FUN IP, Chapter 32 and SMACNA 1966 transverse joints shall be used:

1. Welded flange joint with angle

2. Companion angle flanged joint

C. The following types of longitudinal seams shall be used:

1. Approved lock seams, back brazed, or continuously brazed seams for ducts with largest dimension up to 72 inches

2. Continuously welded or brazed seams for ducts with largest dimension greater than 72 inches

D. Sheet metal minimum thickness, transverse reinforcement between joints, and companion angle joints of ducts with longest side greater than 96 inches shall be in accordance with the following:

| LONGEST SIDE INCHES | SHEET METAL GAGE ALL SIDES | COMPANION ANGLE INCHES | REINFORCEMENT ANGLES INCHES, 24 INCHES ON CENTER MAXIMUM (BACK TO BACK) |
|---|---|---|---|
| _____ | _____ | _____ | _____ |

| | | | |
|---|---|---|---|
| 97 to 108 | 16 | 2 by 2 by 1/8, two tie rods along angle | *Two 2 by 2 by 1/8, two tie rods along angle |
| 109 to 132 | 16 | 2 by 2 by 3/16, two tie rods along angle | *Two 2 by 2 by 3/16, two tie rods along angle |
| 133 and longer | 14 | 2-1/2 by 2-1/2 by 3/16, with tie rods every 24 inches | *Two 2-1/2 by 2-1/2 by 3/16, with tie rods every 24 inches |

3.3.3 Round Sheet Metal Ducts

3.3.3.1 Duct Gages, Joints, And Reinforcement

A. Sheet metal minimum thickness, joints, and reinforcement between joints shall be in accordance with ASHRAE EQUIP IP HDBK, Chapter 16, ASHRAE FUN IP, Chapter 32 and SMACNA 1966.

B. Longitudinal duct joint shall be manufactured by machine, with spiral lockseams to and including 60 inch diameters, and to dimensional tolerances compatible with fittings provided.

C. Ducts shall have supplemental girth angle supports, riveted with solid rivets 6 inches on center to duct. Girth angles shall be located as follows:

| DIAMETER, INCHES | REINFORCEMENT-MAXIMUM SPACING, INCHES |
|---|---|
| 25 to 36 | 1-1/4 by 1-1/4, 1/8 thick, 72 inches on center |
| 37 to 50 | 1-1/4 by 1-1/4, 1/8 thick, 60 inches on center |
| 51 to 60 | 1-1/2 by 1-1/2, 1/8 thick, 48 inches on center |

D. Draw band girth joints are not acceptable.

E. Slip joints shall be made up by coating the male fitting with elastomer sealing materials, exercising care to prevent mastic from entering fitting bore, leaving only a thin annular mastic line exposed internally. Sheet metal screws shall be used to make assembly rigid, not less than four screws per joint, maximum spacing 6 inches. Pop rivets shall not be used. All joints shall be taped and heat sealed.

F. Bolt heads and nuts shall be hex-shaped, 5/16 inch diameter for ducts up to 50 inch diameter, and 3/8 inch diameter for 51 inch diameter ducts and larger.

G. Flanges shall be continuously welded to duct on outside of duct and intermittently welded with 1 inch welds every 4 inches on inside joint face. Excess filler metal shall be removed from inside face. Galvanized areas that have been damaged by welding shall be protected with manufacturer's standard corrosion-resistant coating.

3.3.3.2 Duct Transitions

A. Where the shape of a duct changes, the angle of the side of the transition piece shall not exceed 15 degrees from the straight run of duct connected thereto.

B. Where equipment is installed in ductwork, the angle of the side of the transition piece from the straight run of duct connected thereto shall not exceed 15 degrees on the upstream side of the equipment and 22-1/2 degrees on the downstream side of the equipment.

3.3.4 Transverse Reinforcement Joints

Transverse reinforcements shall be riveted with solid rivets to duct sides 6 inches on center. Transverse reinforcement shall be welded at all corners to form continuous frames.

3.3.5 Joint Gaskets

Flanged joints shall be gasketed with chloroprene full-face gaskets 1/8 inch thick, Shore A 40 durometer hardness. Gaskets shall be one piece, vulcanized at joints.

3.3.6 Radius Elbows

Fabricate elbow proportions and radius elbows in accordance with ASHRAE EQUIP IP HDBK, Chapter 16, ASHRAE FUN IP, Chapter 32 and SMACNA 1966.

3.3.7 Plenum Connections

A. Round duct connections shall be welded joint bellmouth type.

B. Rectangular duct connections shall be bellmouth type, constructed in accordance with ASHRAE EQUIP IP HDBK, Chapter 16, ASHRAE FUN IP, Chapter 32 and SMACNA 1966.

3.3.8 Access Openings

A. Install access panels in ductwork adjacent to fire dampers.

B. Minimum size of access opening shall be 12 by 18 inches, unless precluded by duct dimension.

C. Access openings shall be framed by welded and ground miter joint, 1/8 inch thick strap steel, with 1/4 inch studs welded to frame. Cover plate shall be not less than 16-gage, reinforced as necessary for larger sizes.

D. In lieu of access doors, readily accessible flanged duct sections may be provided upon approval. Provide stable hanger supports for disconnected duct termini.

3.3.9 Duct Supports

A. Install duct support in accordance with ASHRAE EQUIP IP HDBK, Chapter 16, ASHRAE FUN IP, Chapter 32 and SMACNA 1966. Duct hangers shall meet the minimum size specified in ASHRAE EQUIP IP HDBK, Chapter 16, ASHRAE FUN IP, Chapter 32 and SMACNA 1966. Provide two hangers where necessary to eliminate sway. Support attachment to duct surfaces, shall be by solid rivet 4 inches on center.

B. Selection of hanging system shall be at the Contractor's option, and shall take into account the location and precedence of work under other sections, interferences of various piping and electrical conduit, equipment, building configuration, structural and safety factor requirements, vibration, and imposed loads under normal and abnormal service conditions. Support sizes, configurations, and spacings are given to show the minimal type of supporting components required. If installed loads are excessive for the specified hanger spacing, hangers, and accessories heavier-duty components shall be provided. After system startup, any duct support device which, due to length, configuration, or size, vibrates or causes possible failure of a member, shall be replaced or the condition shall otherwise be alleviated. Special care shall be exercised to preclude cascade-type failures.

C. Hanger rods, angles, and straps shall be attached to beam clamps. Concrete inserts, masonry anchors, and fasteners shall be approved for the application.

D. Hardened high-carbon spring-steel fasteners fitted onto beams and miscellaneous structural steel are acceptable upon prior approval of each proposed application and upon field demonstration of conformance to specification requirements. Fasteners shall be made from steel conforming to AISI Type 1055, treated and finished in conformance with SAE AMS 2480, Type Z (zinc phosphate base), Class 2 (supplementary treatment). A 72-hour load-carrying capacity shall be verified by a certified independent laboratory.

E. Hanger spacing shall provide a 20-to-1 safety factor for supported load.

F. Maximum load supported by any two fasteners shall be 100 pounds.

G. Friction rod assemblies are not acceptable.

H. Where support from metal deck systems is involved, support requirements shall be coordinated with installation of metal deck.

I. Ductwork and equipment shall not be hung from roof deck, piping, or other ducts or equipment. Maximum span between any two points shall be 10 feet, with lesser spans as required by duct assemblies, interferences, and permitted loads imposed.

J. There shall be not less than one set of hangers for each point of support. Hangers shall be installed on both sides of all duct turns, branch fittings, and transitions.

K. Hangers shall be sufficiently cross braced to eliminate sway vertically and laterally.

L. Rectangular ducts up to 36 inches shall be supported by strap-type hangers attached at not less than three places to not less than two duct surfaces in different planes.

M. Perforated strap hangers are not acceptable.

N. Rectangular ducting, 36 inches and larger, shall be supported by trapeze hangers. Ducts situated in unconditioned areas and required to have insulation with a vapor-sealed facing shall be supported on trapeze hangers. Hangers shall be spaced far enough out from the side of the duct to permit the duct insulation to be placed on the duct inside the trapeze. Duct hangers shall not penetrate the vapor-sealed facing.

O. Where trapeze hangers are used, the bottom of the duct shall be supported on angles sized as follows:

| WIDTH OF DUCT, INCHES | MINIMUM BOTTOM ANGLE SIZE, INCHES |
|---|---|
| 30 and smaller | 1-1/4 by 1-1/4 by 1/8 |
| 31 to 48 | 1-1/2 by 1-1/2 by 1/8 |
| 49 to 72 | 1-1/2 by 1-1/2 by 3/16 |
| 73 to 96 | 2 by 2 by 1/4 |
| 97 and wider | 3 by 3 by 1/4 |

P. Where ductwork system contains heavy equipment, excluding air-diffusion devices and single-leaf dampers, such equipment shall be hung independently of the ductwork by means of rods or angles of sizes adequate to support the load.

Q. Ducting, when supported from roof purlins, shall not be supported at points greater than one-sixth of the purlin span from the roof truss. Load per hanger shall not exceed 400 pounds when support is from a single purlin or 800 pounds when hanger load is applied halfway between purlins by means of auxiliary support steel provided under this section. When support is not halfway between purlins, the allowable hanger load shall be the product of 400 times the inverse ratio of the longest distance to purlin-to-purlin spacing.

R. When the hanger load exceeds the above limits, provide reinforcing of purlin(s) or additional support beam(s). When an additional beam is used, the beam shall bear on the top chord of the roof trusses, and bearing shall be over gusset plates of top chord. Beam shall be stabilized by connection to roof purlin along bottom flange.

S. Purlins used for supporting fire-protection sprinkler mains, electrical lighting fixtures, electrical power ducts, or cable trays shall be considered fully loaded, and supplemental reinforcing or auxiliary support steel shall be provided for these purlins.

T. Duct supports shall be vibration isolated from structure at points indicated.

U. Provide vibration isolators in discharge ducting system for a distance not less than 50 feet beyond the air handling unit. Deflection of duct and equipment mountings shall be coordinated.

3.3.10 Flexible Connectors For Steel Metal

A. Air-handling equipment, ducts crossing building expansion joints, and fan inlets and outlets shall be connected to upstream and downstream components by treated woven-cloth connectors.

B. Install connectors only after system fans are operative and all vibration isolation mountings have been adjusted. When system fans are operating, connectors shall be free of wrinkles caused by misalignment or fan reaction. Width of surface shall be curvilinear.

3.3.11 Insulation Protection Angles

A. Galvanized 20-gage sheet, formed into an angle with a 2 inch exposed long leg with a 3/8 inch stiffening break at outer edge, and with a variable concealed leg, depending upon insulation thickness, shall be provided.

B. Install angles over all insulation edges terminating by butting against a wall, floor foundation, frame, and similar construction. Fasten angles in place with blind rivets through the protection angle, insulation, and sheet metal duct or plenum. Install angles after final insulation covering has been applied.

3.3.12 Duct Probe Access

Provide holes with neat patches, threaded plugs, or threaded or twist-on caps for air-balancing pitot tube access. Provide extended-neck fittings where probe access area is insulated.

3.3.13 Openings In Roofs And Walls

Building openings are fixed and provide equipment to suit.

3.4 FIELD QUALITY CONTROL

### 3.4.1 Fire Damper Tests

Perform Operational tests on each fire damper in the presence of the Contracting Officer's Representative by enervating fusible link with localized heat. Provide new links and install after successful testing.

### 3.4.2 Ductwork Leakage Tests

Contractor shall conduct complete leakage test of new ductwork in accordance with Section 23 05 93 TESTING, ADJUSTING, AND BALANCING FOR HVAC. Tests shall be performed prior to installing ductwork insulation.

## 3.5 DUCTWORK CLEANING PROVISIONS

Open ducting shall be protected from construction dust and debris in a manner approved by the Contracting Officer's Representative. Dirty assembled ducting shall be cleaned by subjecting all main and branch interior surfaces to airstreams moving at velocities two times specified working velocities, at static pressures within maximum ratings. This may be accomplished by: filter-equipped portable blowers which remain the Contractor's property; wheel-mounted, compressed-air operated perimeter lances which direct the compressed air and which are pulled in the direction of normal airflow; and other means approved by the Contracting Officer's Representative. Compressed air used for cleaning ducting shall be water- and oil- free. After construction is complete, and prior to acceptance of the work, construction dust and debris shall be removed from exterior surfaces. SMACNA 1987.

## 3.6 OPERATION AND MAINTENANCE

A. Contractor shall submit 4 copies of the Operation and Maintenance Manuals 30 calendar days prior to testing the medium/high pressure ductwork systems. Data shall be updated and resubmitted for final approval no later than 30 calendar days prior to contract completion.

B. Operation and Maintenance Manuals shall be consistent with manufacturer's standard brochures, schematics, printed instructions, general operating procedures and safety precautions.

-- End of Section 23 31 13 --

SECTION 23 82 02
UNITARY HEATING AND COOLING EQUIPMENT

PART 1 GENERAL

1.1 REFERENCES

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

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

| | |
|---|---|
| AHRI 700 | (2006; Addendum 1 2009) Specifications for Fluorocarbon Refrigerants |
| ANSI/AHRI 210/240 | (2008) Performance Rating of Unitary Air-Conditioning & Air-Source Heat Pump Equipment |
| ANSI/AHRI 460 | (2005) Performance Rating of Remote Mechanical-Draft Air-Cooled Refrigerant Condensers |
| ANSI/AHRI 495 | (2005) Performance Rating of Refrigerant Liquid Receivers |
| ANSI/AHRI 500 | (2000) Variable Capacity Positive Displacement Refrigerant Compressors and Compressor Units for Air-Conditioning and Heat Pump Applications |

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

| | |
|---|---|
| ANSI/ASHRAE 15 & 34 | (2010; Addenda a, b, c, d, e, f, g, h, I, j, k, l, n and o; Errata 2011) ANSI/ASHRAE Standard 15-Safety Standard for Refrigeration Systems and ANSI/ASHRAE Standard 34-Designation and Safety Classification of Refrigerants |

AMERICAN WELDING SOCIETY (AWS)

| | |
|---|---|
| AWS Z49.1 | (2005) Safety in Welding, Cutting and Allied Processes |

ASME INTERNATIONAL (ASME)

| | |
|---|---|
| ASME BPVC SEC IX | (2010) BPVC Section IX-Welding and Brazing Qualifications |

| | |
|---|---|
| ASME BPVC SEC VIII D1 | (2010) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1 |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A 307 | (2007b) Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength |
| ASTM B 117 | (2009) Standing Practice for Operating Salt Spray (Fog) Apparatus |
| ASTM C 1071 | (2005e1) Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material) |
| ASTM D 520 | (2000; R 2005) Zinc Dust Pigment |
| ASTM F 104 | (2003) Standard Classification System for Nonmetallic Gasket Materials |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| NEMA ICS 6 | (1993; R 2011) Enclosures |
| NEMA MG 1 | (2011; Errata 2012) Motors and Generators |
| NEMA MG 2 | (2001; Rev 1 2007) Safety Standard and Guide for Selection, Installation, and Use of Electric Motors and Generators |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 70 | (2014; AMD 1 2013; Errata 1 2013; AMD 2 2013; Errata 2 2013; AMD 3 2014; Errata 3 2014) National Electrical Code |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 1995 | (2011) Heating and Cooling Equipment |
| UL 586 | (2009) Standard for High-Efficiency Particulate, Air Filter Units |
| UL 900 | (2004; Reprint Nov 2009) Standard for Air Filter Units |

## 1.2 SYSTEM DESCRIPTION

Provide electrical equipment, motors, motor efficiencies, and wiring which are in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Electrical motor driven equipment specified shall be provided complete with motors, motor starters, and controls. Electrical characteristics shall be as shown, and unless otherwise indicated, all motors of 1 horsepower and above with open, dripproof, totally enclosed, or explosion proof fan cooled enclosures, shall be the premium efficiency type in accordance with NEMA MG 1. Field wiring shall be in accordance with manufacturer's instructions. Each motor shall conform to NEMA MG 1 and NEMA MG 2 and be of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor. Motors shall be continuous duty with the enclosure specified. Motor starters shall be provided complete with thermal overload protection and other appurtenances necessary for the motor control indicated. Motors shall be furnished with a magnetic across-the-line or reduced voltage type starter as required by the manufacturer. Motor duty requirements shall allow for maximum frequency start-stop operation and minimum encountered interval between start and stop. Motors shall be sized for the applicable loads. Motor torque shall be capable of accelerating the connected load within 20 seconds with 80 percent of the rated voltage maintained at motor terminals during one starting period. Motor bearings shall be fitted with grease supply fittings and grease relief to outside of enclosure. Manual or automatic control and protective or signal devices required for the operation specified and any control wiring required for controls and devices specified, but not shown, shall be provided.

## 1.3 SUBMITTALS

Contracting Officer's written approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Drawings

Drawings provided in adequate detail to demonstrate compliance with contract requirements, as specified.

SD-03 Product Data

Materials and Equipment

Manufacturer's standard catalog data, at least 5 weeks prior to the purchase or installation of a particular component, highlighted to show material, size, options, performance charts and curves, etc. in adequate detail to demonstrate compliance with contract requirements. Data shall include manufacturer's recommended installation instructions and procedures. If vibration isolation is specified for a unit, vibration isolator literature shall be included containing catalog cuts and certification that the

isolation characteristics of the isolators provided meet the manufacturer's recommendations. Data shall be submitted for each specified component.

Coil Corrosion Protection

Product data on the type coating selected, the coating thickness, the application process used, the estimated heat transfer loss of the coil, and verification of conformance with the salt spray test requirement.

## 1.4 QUALITY ASSURANCE

Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories that may be required. Carefully investigate the plumbing, fire protection, electrical, structural and finish conditions that would affect the work to be performed and arrange such work accordingly, furnishing required offsets, fittings, and accessories to meet such conditions. Submit drawings consisting of:

a. Equipment layouts which identify assembly and installation details.

b. Plans and elevations which identify clearances required for maintenance and operation.

c. Wiring diagrams which identify each component individually and interconnected or interlocked relationships between components.

d. Foundation drawings, bolt-setting information, and foundation bolts prior to concrete foundation construction for equipment indicated or required to have concrete foundations.

e. Details, if piping and equipment are to be supported other than as indicated, which include loadings and type of frames, brackets, stanchions, or other supports.

f. Automatic temperature control diagrams and control sequences.

g. Installation details which includes the amount of factory set superheat and corresponding refrigerant pressure/temperature.

## 1.5 DELIVERY, STORAGE, AND HANDLING

Stored items shall be protected from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Proper protection and care of all material both before and during installation shall be the Contractor's responsibility. Replace any materials found to be damaged at the Contractor's expense. During installation, piping and similar openings shall be capped to keep out dirt and other foreign matter.

# PART 2 PRODUCTS

## 2.1 MATERIALS AND EQUIPMENT

### 2.1.1 Standard Products

Provide Materials and equipment that are standard products of a manufacturer regularly engaged in the manufacturing of such products, which are of a similar material, design and workmanship. The standard products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2 year use shall include applications of equipment and materials under similar circumstances and of similar size. The 2 years experience shall be satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturer's catalogs, or brochures. Products having less than a 2 year field service record will be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown. Products shall be supported by a service organization. System components shall be environmentally suitable for the indicated locations.

### 2.1.2 Nameplates

Major equipment including compressors, condensers, receivers, heat exchanges, fans, and motors shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment. Plates shall be durable and legible throughout equipment life and made of stainless steel. Plates shall be fixed in prominent locations with nonferrous screws or bolts.

### 2.1.3 Safety Devices

Exposed moving parts, parts that produce high operating temperature, parts which may be electrically energized, and parts that may be a hazard to operating personnel shall be insulated, fully enclosed, guarded, or fitted with other types of safety devices. Safety devices shall be installed so that proper operation of equipment is not impaired. Welding and cutting safety requirements shall be in accordance with AWS Z49.1.

## 2.2 UNITARY EQUIPMENT, SPLIT SYSTEM

Unit shall be an air-cooled, split system which employs a remote condensing unit, a separate indoor unit, and interconnecting refrigerant piping. Unit shall be the air-conditioning type conforming to applicable Underwriters Laboratories (UL) standards including UL 1995. Unit shall be rated in accordance with ANSI/AHRI 210/240. Unit shall be provided with necessary fans, air filters, coil frost protection, liquid receiver, internal dampers, mixing boxes, supplemental heat, and cabinet construction as specified in paragraph "Unitary Equipment Components". The remote unit shall be as specified in paragraph CONDENSING UNIT. Evaporator or supply fans shall be assembled with a turbo fan propeller, direct driven by a single motor. Condenser or outdoor fans shall be the manufacturer's standard for the unit specified and may be either propeller or centrifugal scroll type. Fan and condenser motors shall have dripproof enclosures.

2.2.1 Air-to-Refrigerant Coil

Coils shall have copper or aluminum tubes of 3/8 inch minimum diameter with copper or aluminum fins that are mechanically bonded or soldered to the tubes. Coil shall be protected in accordance with paragraph COIL CORROSION PROTECTION. Casing shall be galvanized steel or aluminum. Contact of dissimilar metals shall be avoided. Coils shall be tested in accordance with ANSI/ASHRAE 15 & 34 at the factory and be suitable for the working pressure of the installed system. Each coil shall be dehydrated and sealed after testing and prior to evaluation and charging. Each unit shall be provided with a factory operating charge of refrigerant and oil or a holding charge. Unit shipped with a holding charge shall be field charged. Separate expansion devices shall be provided for each compressor circuit.

2.2.2 Compressor

Compressor shall be a DL rotary compressor with variable speed inverter technology type capable of operating at partial load conditions. Compressor shall be capable of continuous operation down to the lowest step of unloading as specified. Compressors of 10 tons and larger shall be provided with capacity reduction devices to produce automatic capacity reduction of at least 50 percent. If standard with the manufacturer, two or more compressors may be used in lieu of a single compressor with unloading capabilities, in which case the compressors will operate in sequence, and each compressor shall have an independent refrigeration circuit through the condenser and evaporator. Each compressor shall start in the unloaded position. Each compressor shall be provided with vibration isolators, crankcase heater, thermal overloads, lubrication pump, high pressure safety cutoffs and protection against short cycling.

2.2.3 Refrigeration Circuit

Refrigerant-containing components shall comply with ANSI/ASHRAE 15 & 34 and be factory tested, cleaned, dehydrated, charged, and sealed. Refrigerant charging valves and connections, and pumpdown valves shall be provided for each circuit. Filter-drier shall be provided in each liquid line and be reversible-flow type. Refrigerant flow control devices shall be an adjustable superheat thermostatic expansion valve with external equalizer matched to coil, capillary or thermostatic control, and a pilot solenoid controlled, leak-tight, four-way refrigerant flow reversing valve. A refrigerant suction line thermostatic control shall be provided to prevent freeze-up in event of loss of water flow during heating cycle.

2.2.4 Unit Controls

Unit shall be internally prewired with a 24 volt control circuit powered by an internal transformer. Terminal blocks shall be provided for power wiring and external control wiring. Unit shall have cutoffs for high pressure, low oil pressure for compressors with positive displacement oil pumps, supply fan failure, and safety interlocks on all service panels. Head pressure controls shall sustain unit operation with ambient temperature of 0 degrees F. Adjustable-cycle timers shall prevent short-cycling. Multiple compressors shall be staged by means of a time delay. Unit shall be internally protected by fuses or a circuit breaker in accordance with UL 1995. Low cost cooling shall be made possible by means of a control

circuit which will modulate dampers to provide 100 percent outside air while locking out compressors.

## 2.3 REMOTE CONDENSING UNIT

Each remote condenser coil shall be fitted with a manual isolation valve and an access valve on the coil side. Saturated refrigerant condensing temperature shall not exceed 120 degrees F at 95 degrees F ambient. Unit shall be provided with low ambient condenser controls to ensure proper operation in an ambient temperature of 0 degrees F. Fan and cabinet construction shall be provided as specified in paragraph "Unitary Equipment Components". Fan and condenser motors shall have dripproof enclosures.

### 2.3.1 Air-Cooled Condenser

Unit shall be rated in accordance with ANSI/AHRI 460 and conform to the requirements of UL 1995. Unit shall be factory fabricated, tested, packaged, and self-contained. Unit shall be complete with casing, propeller or centrifugal type fans, heat rejection coils, connecting piping and wiring, and all necessary appurtenances.

#### 2.3.1.1 Connections

Interconnecting refrigeration piping, electrical power, and control wiring between the condensing unit and the indoor unit shall be provided as required and as indicated. Electrical and refrigeration piping terminal connections between condensing unit and evaporator units shall be provided.

#### 2.3.1.2 Head Pressure Control and Liquid Subcooling

Low ambient control for multi-circuited units serving more than one evaporator coil shall provide independent condenser pressure controls for each refrigerant circuit. Controls shall be set to produce a minimum of 95 degrees F saturated refrigerant condensing temperature. Unit shall be provided with a liquid subcooling circuit which shall ensure proper liquid refrigerant flow to the expansion device over the specified application range of the condenser. Unit shall be provide with manufacturer's standard liquid subcooling. Subcooling circuit shall be liquid sealed.

#### 2.3.1.3 Condensing Coil

Coils shall have copper or aluminum tubes of 3/8 inch minimum diameter with copper or aluminum fins that are mechanically bonded or soldered to the tubes. Coil shall be protected in accordance with paragraph COIL CORROSION PROTECTION. Casing shall be galvanized steel or aluminum. Contact of dissimilar metals shall be avoided. Coils shall be tested in accordance with ANSI/ASHRAE 15 & 34 at the factory and be suitable for the working pressure of the installed system. Each coil shall be dehydrated and sealed after testing and prior to evaluation and charging. Each unit shall be provided with a factory operating charge of

refrigerant and oil or a holding charge. Unit shipped with a holding charge shall be field charged. Separate expansion devices shall be provided for each compressor circuit.

2.3.1.4 Unit Controls

The control system shall be complete with required accessories for regulating condenser pressure by fan cycling, solid-state variable fan speed, modulating condenser coil or fan dampers, flooding the condenser, or a combination of the above. Unit mounted control panels or enclosures shall be constructed in accordance with applicable requirements of NFPA 70 and housed in NEMA ICS 6, Class 1 or 3A enclosures. Controls shall include control transformer, fan motor starters, solid-state speed control, overload protective devices, interface with local and remote components, and intercomponent wiring to terminal block points.

2.3.2 Compressor

Unit shall be rated in accordance with ANSI/AHRI 500. Compressor shall be DL rotary compressor with variable compressor speed inverter technology capable of operating at partial load conditions. Compressor shall be capable of continuous operation down to the lowest step of unloading as specified. Units 120,000 Btuh and larger shall be provided with capacity reduction devices to produce automatic capacity reduction of at least 50 percent. If standard with the manufacturer, two or more compressors may be used in lieu of a single compressor with unloading capabilities, in which case the compressors will operate in sequence, and each compressor shall have an independent refrigeration circuit through the condenser and evaporator. Each compressor shall start in the unloaded position. Each compressor shall be provided with vibration isolators, crankcase heater, lubrication pump, thermal overloads, and high pressure safety cutoffs and protection against short cycling.

2.4 EQUIPMENT EFFICIENCY

Unit shall have an efficiency as indicated on the drawings.

2.5 UNITARY EQUIPMENT COMPONENTS

2.5.1 Refrigerant and Oil

Refrigerant shall be one of the fluorocarbon gases. Refrigerants shall have number designations and safety classifications in accordance with ANSI/ASHRAE 15 & 34. Refrigerants shall meet the requirements of AHRI 700 as a minimum. Refrigerants shall have an Ozone Depletion Potential (ODP) of less than or equal to 0.05. Provide and install a complete charge of refrigerant for the installed system as recommended by the manufacturer. Lubricating oil shall be of a type and grade recommended by the manufacturer for each compressor. Where color leak indicator dye is incorporated, charge shall be in accordance with manufacturer's recommendation.

2.5.2 Fans

Fan wheel shafts shall be supported by either maintenance-accessible lubricated antifriction block-type bearings, or permanently lubricated ball bearings. Unit fans shall be selected to produce the cfm required at the fan total pressure. Motor starters, if applicable, shall be magnetic across-the-line type with a dripproof enclosure. Thermal overload protection shall be of the manual or automatic-reset type. Fan wheels or propellers shall be constructed of aluminum or galvanized steel. Fan casings shall be constructed of aluminum or galvanized steel. Steel elements of fans, except fan shafts, shall be hot-dipped galvanized after fabrication or fabricated of mill galvanized steel. Mill-galvanized steel surfaces and edges damaged or cut during fabrication by forming, punching, drilling, welding, or cutting shall be recoated with an approved zinc-rich compound. Fan wheels or propellers shall be statically and dynamically balanced. Direct-drive fan motors shall be of the multiple-speed variety. Belt-driven fans shall have adjustable sheaves to provide fan-speed adjustment. The sheave size shall be selected so that the fan speed at the approximate midpoint of the sheave adjustment will produce the specified air quantity. Propeller fans shall be direct-drive drive type. Each drive will be independent of any other drive. Drive bearings shall be protected with water slingers or shields.

2.5.3 Air Filters

Air filters shall be listed in accordance with requirements of UL 900, except high efficiency particulate air filters of 99.97 percent efficiency by the DOP Test Method shall be as listed under the label service and shall meet the requirements of UL 586.

2.5.4 Coil Frost Protection

Each circuit shall be provided with a coil frost protection system which is a manufacturer's standard. The coil frost protection system shall use a temperature sensor in the suction line of the compressor to shut the compressor off when coil frosting occurs. Timers shall be used to prevent the compressor from rapid cycling.

2.5.5 Pressure Vessels

2.5.5.1 Liquid Receiver

A liquid receiver shall be provided when a system's condenser or compressor does not contain a refrigerant storage capacity of at least 20 percent in excess of a fully charged system. Receiver shall be designed, filled, and rated in accordance with the recommendations of ANSI/AHRI 495, except as modified herein. Receiver shall be fitted to include an inlet connection; an outlet drop pipe with oil seal and oil drain where necessary; two bull's-eye liquid level sight glass in same vertical plane, 90 degrees apart and perpendicular to axis of receiver or external gauge glass with metal guard and automatic stop valves; thermal well for thermostat; and purge, charge, equalizing, pressurizing, plugged drain and service valves on the inlet and outlet connections. Receiver shall be provided with a relief valve of capacity and setting in accordance with ANSI/ASHRAE 15 & 34.

2.5.6 Cabinet Construction

Casings for the specified unitary equipment shall be constructed of galvanized steel or aluminum sheet metal and galvanized or aluminum structural members. Minimum thickness of single wall exterior surfaces shall be 20 gauge galvanized steel or 0.064 inch thick aluminum on units with a capacity less than 20 tons. Casing shall be fitted with lifting provisions, access panels or doors, fan vibration isolators, electrical control panel, corrosion-resistant components, structural support members, insulated condensate drip pan and drain, and internal insulation in the cold section of the casing. Where double-wall insulated construction is proposed, minimum exterior galvanized sheet metal thickness shall be 20 gauge. Provisions to permit replacement of major unit components shall be incorporated. Penetrations of cabinet surfaces, including the floor, shall be sealed. Unit shall be fitted with a drain pan which extends under all areas where water may accumulate. Drain pan shall be fabricated from Type 300 stainless steel, galvanized steel with protective coating as required, or an approved plastic material. Pan insulation shall be water impervious. Extent and effectiveness of the insulation of unit air containment surfaces shall prevent, within limits of the specified insulation, heat transfer between the unit exterior and ambient air, heat transfer between the two conditioned air streams, and condensation on surfaces. Insulation shall conform to ASTM C 1071. Paint and finishes shall comply with the requirements specified in paragraph FACTORY COATING.

2.5.6.1 Indoor Cabinet

Indoor cabinets shall be suitable for the specified indoor service and enclose all unit components.

2.5.6.2 Outdoor Cabinet

Outdoor cabinets shall be suitable for outdoor service with a weathertight, insulated and corrosion-protected structure. Cabinets constructed exclusively for indoor service which have been modified for outdoor service are not acceptable.

2.6 ACCESSORIES

2.6.1 Refrigerant Signs

2.6.1.1 Installation Identification

Each new refrigeration system shall be provided with a refrigerant sign which indicates the following as a minimum:

a. Contractor's name.

b. Refrigerant number and amount of refrigerant.

c. The lubricant identity and amount.

d. Field test pressure applied.

2.6.1.2 Controls and Piping Identification

Refrigerant systems containing more than 110 lb of refrigerant shall be provided with refrigerant signs which designate the following as a minimum:

a. Valves or switches for controlling the refrigerant flow.

b. Pressure limiting device(s).

2.6.2 Gaskets

Gaskets shall conform to ASTM F 104 - classification for compressed sheet with nitrile binder and acrylic fibers for maximum 700 degrees F service.

2.6.3 Bolts and Nuts

Bolts and nuts shall be in accordance with ASTM A 307. The bolt head shall be marked to identify the manufacturer and the standard with which the bolt complies in accordance with ASTM A 307.

2.6.4 Bird Screen

Screen shall be 0.063 inch diameter aluminum wire or 0.031 inch diameter stainless steel wire.

2.7 FINISHES

2.7.1 Factory Coating

2.7.1.1 Coil Corrosion Protection

Provide coil with a uniformly applied epoxy electrodeposition type coating to all coil surface areas without material bridging between fins. Coating shall be applied at either the coil or coating manufacturer's factory. Coating process shall encure complete coil encapsulation. Coating shall be capable of withstanding a minimum 1,000 hours exposure to the salt spray test specified in ASTM B 117 using a 5 percent sodium chloride solution.

2.7.1.2 Equipment and Components

Unless otherwise specified, equipment and component items, when fabricated from ferrous metal, shall be factory finished with the manufacturer's standard finish, except that items located outside of buildings shall have weather resistant finishes that will withstand 500 hours exposure to the salt spray test specified in ASTM B 117 using a 5 percent sodium chloride solution. Immediately after completion of the test, the specimen shall show no signs of blistering, wrinkling, cracking, or loss of adhesion and no sign of rust creepage beyond 1/8 inch on either side of the scratch mark. Cut edges of galvanized surfaces where hot-dip galvanized sheet steel is used shall be coated with a zinc-rich coating conforming to ASTM D 520, Type I.

## 2.8 SUPPLEMENTAL COMPONENTS/SERVICES

### 2.8.1 Refrigerant Piping

Refrigerant piping for split-system unitary equipment shall be provided and installed in accordance with Section 23 23 00 REFRIGERANT PIPING.

### 2.8.2 Temperature Controls

Temperature controls shall be provided and installed.

# PART 3 EXECUTION

## 3.1 EXAMINATION

After becoming familiar with all details of the work, perform Verification of Dimensions in the field, and advise the Contracting Officer's Representative and Contracting Officer of any discrepancy before performing any work.

## 3.2 INSTALLATION

Work shall be performed in accordance with the manufacturer's published diagrams, recommendations, and equipment warranty requirements. Where equipment is specified to conform to the requirements of ASME BPVC SEC VIII D1and ASME BPVC SEC IX, the design, fabrication, and installation of the system shall conform to ASME BPVC SEC VIII D1 and ASME BPVC SEC IX.

### 3.2.1 Equipment

Refrigeration equipment and the installation thereof shall conform to ANSI/ASHRAE 15 & 34. Necessary supports shall be provided for all equipment, appurtenances, and pipe as required, including frames or supports for compressors, pumps, cooling towers, condensers, and similar items. Compressors shall be isolated from the building structure. If mechanical vibration isolators are not provided, vibration absorbing foundations shall be provided. Each foundation shall include isolation units consisting of machine and floor or foundation fastenings, together with intermediate isolation material. Other floor-mounted equipment shall be set on not less than a 6 inch concrete pad doweled in place. Concrete foundations for floor mounted pumps shall have a mass equivalent to three times the weight of the components, pump, base plate, and motor to be supported. In lieu of concrete pad foundation, concrete pedestal block with isolators placed between the pedestal block and the floor may be provided. Concrete pedestal block shall be of mass not less than three times the combined pump, motor, and base weights. Isolators shall be selected and sized based on load-bearing requirements and the lowest frequency of vibration to be isolated. Lines connected to pumps mounted on pedestal blocks shall be provided with flexible connectors. Foundation drawings, bolt-setting information, and foundation bolts shall be furnished prior to concrete foundation construction for all equipment indicated or required to

have concrete foundations. Equipment shall be properly leveled, aligned, and secured in place in accordance with manufacturer's instructions.

### 3.2.2 Field Painting

Painting required for surfaces not otherwise specified, and finish painting of items only primed at the factory are specified in Section 09 90 00 PAINTS AND COATINGS.

## 3.3 CLEANING AND ADJUSTING

Equipment shall be wiped clean, with all traces of oil, dust, dirt, or paint spots removed. Temporary filters shall be provided for all fans that are operated during construction, and new filters shall be installed after all construction dirt has been removed from the building. System shall be maintained in this clean condition until final acceptance. Bearings shall be properly lubricated with oil or grease as recommended by the manufacturer. Belts shall be tightened to proper tension. Control valves and other miscellaneous equipment requiring adjustment shall be adjusted to setting indicated or directed. Fans shall be adjusted to the speed indicated by the manufacturer to meet specified conditions. Testing, adjusting, and balancing shall be as specified in Section 23 05 93 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS.

## 3.4 REFRIGERANT TESTS, CHARGING, AND START-UP

Split-system refrigerant piping systems shall be tested and charged as specified in Section 23 23 00 REFRIGERANT PIPING. Packaged refrigerant systems which are factory charged shall be checked for refrigerant and oil capacity to verify proper refrigerant levels in accordance with manufacturer's recommendations. Following charging, packaged systems shall be tested for leaks with a halide torch or an electronic leak detector.

### 3.4.1 Refrigerant Leakage

If a refrigerant leak is discovered after the system has been charged, the leaking portion of the system shall immediately be isolated from the remainder of the system and the refrigerant pumped into the system receiver or other suitable container. Under no circumstances shall the refrigerant be discharged into the atmosphere.

3.4.2 Contractor's Responsibility

Take steps, at all times during the installation and testing of the refrigeration system, to prevent the release of refrigerants into the atmosphere. The steps shall include, but not be limited to, procedures which will minimize the release of refrigerants to the atmosphere and the use of refrigerant recovery devices to remove refrigerant from the system and store the refrigerant for reuse or reclaim. At no time shall more than 3 ounces of refrigerant be released to the atmosphere in any one occurrence. Any system leaks within the first year shall be repaired in accordance with the requirements herein at no cost to the Government including material, labor, and refrigerant if the leak is the result of defective equipment, material, or installation.

-- End of Section 23 82 02 --

SECTION 26 00 00
BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM D 709 | (2001; R 2007) Laminated Thermosetting Materials |

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

| | |
|---|---|
| IEEE 100 | (2000; Archived) The Authoritative Dictionary of IEEE Standards Terms |
| IEEE C2 | (2012; Errata 2012; INT 1-4 2012; INT 5-7 2013) National Electrical Safety Code |
| IEEE C57.12.28 | (2005) Standard for Pad-Mounted Equipment - Enclosure Integrity |
| IEEE C57.12.29 | (2005) Pad-Mounted Equipment - Enclosure Integrity for Coastal Environments |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| NEMA 250 | (2008) Enclosures for Electrical Equipment (1000 Volts Maximum) |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 70 | (2014; AMD 1 2013; Errata 1 2013; AMD 2 2013; Errata 2 2013; AMD 3 2014; Errata 3 2014) National Electrical Code |

1.2 RELATED REQUIREMENTS

This section applies to all sections of Division 26, ELECTRICAL, of this project specification unless specified otherwise in the individual sections.

1.3 DEFINITIONS

a. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, shall be as defined in IEEE 100.

b. The technical sections referred to herein are those specification sections that describe products, installation procedures, and equipment operations and that refer to this section for detailed description of submittal types.

c. The technical paragraphs referred to herein are those paragraphs in PART 2 - PRODUCTS and PART 3 - EXECUTION of the technical sections that describe products, systems, installation procedures, equipment, and test methods.

## 1.4 ELECTRICAL CHARACTERISTICS

Electrical characteristics for this project shall be 60 Hz, and 208 volts secondary, three phase, four wire.

## 1.5 ADDITIONAL SUBMITTALS INFORMATION

Submittals required in other sections that refer to this section must conform to the following additional requirements as applicable.

### 1.5.1 Shop Drawings (SD-02)

Include wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure a coordinated installation. Wiring diagrams shall identify circuit terminals and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Drawings shall indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices.

### 1.5.2 Product Data (SD-03)

Submittal shall include performance and characteristic curves.

## 1.6 QUALITY ASSURANCE

### 1.6.1 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

### 1.6.2 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in the technical section.

#### 1.6.2.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

#### 1.6.2.2 Material and Equipment Manufacturing Date

Products manufactured more than 3 years prior to date of delivery to site shall not be used, unless specified otherwise.

## 1.7 WARRANTY

The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

## 1.8 POSTED OPERATING INSTRUCTIONS

Provide for each system and principal item of equipment as specified in the technical sections for use by operation and maintenance personnel. The operating instructions shall include the following:

a. Wiring diagrams, control diagrams, and control sequence for each principal system and item of equipment.

b. Start up, proper adjustment, operating, lubrication, and shutdown procedures.

c. Safety precautions.

d. The procedure in the event of equipment failure.

e. Other items of instruction as recommended by the manufacturer of each system or item of equipment.

Print or engrave operating instructions and frame under glass or in approved laminated plastic. Post instructions where directed. For operating instructions exposed to the weather, provide weather-resistant materials or weatherproof enclosures. Operating instructions shall not fade when exposed to sunlight and shall be secured to prevent easy removal or peeling.

## 1.9 MANUFACTURER'S NAMEPLATE

Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

## 1.10 FIELD FABRICATED NAMEPLATES

ASTM D 709. Provide laminated plastic nameplates for each equipment enclosure, relay, switch, and device; as specified in the technical sections or as indicated on the drawings. Each nameplate inscription shall identify the function and, when applicable, the position. Nameplates shall be melamine plastic, 0.125 inch thick, white with black center core. Surface shall be matte finish. Corners shall be square. Accurately align lettering and engrave into the core. Minimum size of nameplates shall be one by 2.5 inches. Lettering shall be a minimum of 0.25 inch high normal block style.

## 1.11 WARNING SIGNS

Provide warning signs for the enclosures of electrical equipment including substations, pad-mounted transformers, pad-mounted switches, generators, and switchgear having a nominal rating exceeding 600 volts.

a. When the enclosure integrity of such equipment is specified to be in accordance with IEEE C57.12.28 or IEEE C57.12.29, such as for pad-mounted transformers, provide self-adhesive warning signs on the outside of the high voltage compartment door(s). Sign shall be a decal and shall have nominal dimensions of 7 by 10 inches with the legend "DANGER HIGH VOLTAGE" printed in two lines of nominal 2 inch high letters. The word "DANGER" shall be in white letters on a red background and the words "HIGH VOLTAGE" shall be in black letters on a white background. Decal shall be Panduit No. PPSO710D72 or approved equal.

b. When such equipment is guarded by a fence, mount signs on the fence. Provide metal signs having nominal dimensions of 14 by 10 inches with the legend "DANGER HIGH VOLTAGE KEEP OUT" printed in three lines of nominal 3 inch high white letters on a red and black field.

## 1.12 ELECTRICAL REQUIREMENTS

Electrical installations shall conform to IEEE C2, NFPA 70, and requirements specified herein.

## 1.13 INSTRUCTION TO GOVERNMENT PERSONNEL

Where specified in the technical sections, furnish the services of competent instructors to give full instruction to designated Government personnel in the adjustment, operation, and maintenance of the specified systems and equipment, including pertinent safety requirements as required. Instructors shall be thoroughly familiar with all parts of the installation and shall be trained in operating theory as well as practical operation and maintenance work. Instruction shall be given during the first regular work week after the equipment or system has been accepted and turned over to the Government for regular operation. The number of man-days (8 hours per day) of instruction furnished shall be as specified in the individual section. When more than 4 man-days of instruction are specified, use approximately half of the time for classroom instruction. Use other time for instruction with equipment or system. When significant changes or modifications in the equipment or system are made under the terms of the contract, provide additional instructions to acquaint the operating personnel with the changes or modifications.

# PART 2 PRODUCTS

## 2.1 FACTORY APPLIED FINISH

Electrical equipment shall have factory-applied painting systems which shall, as a minimum, meet the requirements of NEMA 250 corrosion-resistance test and the additional requirements specified in the technical sections.

# PART 3 EXECUTION

## 3.1 FIELD APPLIED PAINTING

Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Painting shall be as specified in Section 09 90 00 PAINTS AND COATINGS or in the section specifying the associated electrical equipment.

## 3.2 FIELD FABRICATED NAMEPLATE MOUNTING

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

## 3.3 WARNING SIGN MOUNTING

Provide the number of signs required to be readable from each accessible side, but space the signs a maximum of 30 feet apart.

-- End of Section 26 00 00 --

SECTION 26 08 00
APPARATUS INSPECTION AND TESTING

PART 1 GENERAL

1.1 REFERENCES

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

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

| | |
|---|---|
| NETA ATS | (2013) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems |

1.2 RELATED REQUIREMENTS

Section 26 00 00 BASIC ELECTRICAL MATERIALS AND METHODS applies to this section with additions and modifications specified herein.

1.3 SUBMITTALS

Contracting Officer's written approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-06 Test Reports

Acceptance tests and inspections

SD-07 Certificates

Qualifications of organization, and lead engineering technician

Acceptance test and inspections procedure

1.4 QUALITY ASSURANCE

1.4.1 Qualifications

Contractor shall engage the services of a qualified testing organization to provide inspection, testing, calibration, and adjustment of the electrical distribution system and generation equipment listed in paragraph entitled "Acceptance Tests and Inspections" herein. Organization shall be independent of the supplier, manufacturer, and installer of the equipment. The organization shall be a first tier subcontractor. No work required by this section of the specification shall be performed by a second tier subcontractor.

a. Submit name and qualifications of organization. Organization shall have been regularly engaged in the testing of electrical materials, devices, installations, and systems for a minimum of 5 years. The organization shall have a calibration program, and test instruments used shall be calibrated in accordance with NETA ATS.

b. Submit name and qualifications of the lead engineering technician performing the required testing services. Include a list of three comparable jobs performed by the technician with specific names and telephone numbers for reference. Testing, inspection, calibration, and adjustments shall be performed by an engineering technician, certified by NETA or the National Institute for Certification in Engineering Technologies (NICET) with a minimum of 5 years' experience inspecting, testing, and calibrating electrical distribution and generation equipment, systems, and devices.

1.4.2 Acceptance Tests and Inspections Reports

Submit certified copies of inspection reports and test reports. Reports shall include certification of compliance with specified requirements, identify deficiencies, and recommend corrective action when appropriate. Type and neatly bind test reports to form a part of the final record. Submit test reports documenting the results of each test not more than 10 days after test is completed.

1.4.3 Acceptance Test and Inspections Procedure

Submit test procedure reports for each item of equipment to be field tested at least 45 days prior to planned testing date. Do not perform testing until after test procedure has been approved.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.1 ACCEPTANCE TESTS AND INSPECTIONS

Testing organization shall perform acceptance tests and inspections. Test methods, procedures, and test values shall be performed and evaluated in accordance with NETA ATS, the manufacturer's recommendations, and paragraph entitled "Field Quality Control" of each applicable specification section. Tests identified as optional in NETA ATS are not required unless otherwise specified. Equipment shall be placed in service only after completion of required tests and evaluation of the test results have been completed. Contractor shall supply to the testing organization complete sets of shop drawings, settings of adjustable devices, and other information necessary for an accurate test and inspection of the system prior to the performance of any final testing. Contracting Officer’s Representative shall be notified at least 14 days in advance of when tests will be conducted by the testing organization. Perform acceptance tests and inspections on applicable equipment and systems specified in the following sections:

a. Section 26 32 13 SINGLE OPERATION GENERATOR SETS. Functional engine shutdown tests, vibration base-line test, and load bank test shall not be performed by the testing organization. These tests shall be performed by the start-up engineer.

b. Section 26 36 23 AUTOMATIC TRANSFER SWITCHES

## 3.2 SYSTEM ACCEPTANCE

Final acceptance of the system is contingent upon satisfactory completion of acceptance tests and inspections.

## 3.3 PLACING EQUIPMENT IN SERVICE

A representative of the approved testing organization shall be present when equipment tested by the organization is initially energized and placed in service.

-- End of Section 26 08 00 --

SECTION 26 20 00
ELECTRICAL DISTRIBUTION SYSTEM

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM B 1 | (2001; R 2007) Standard Specification for Hard-Drawn Copper Wire |
| ASTM B 8 | (2004) Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft |
| ASTM D 709 | (2001; R 2007) Laminated Thermosetting Materials |

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

| | |
|---|---|
| IEEE 100 | (2000; Archived) The Authoritative Dictionary of IEEE Standards Terms |
| IEEE 81 | (1983) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System |
| IEEE C2 | (2012; Errata 2012; INT 1-4 2012; INT 5-7 2013) National Electrical Safety Code |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| ANSI C80.1 | (2005) American National Standard for Electrical Rigid Steel Conduit (ERSC) |
| ANSI C80.3 | (2005) American National Standard for Electrical Metallic Tubing (EMT) |
| ANSI C80.5 | (2005) American National Standard for Electrical Rigid Aluminum Conduit |
| ANSI Z535.4 | (2007) American National Standard for Product Safety Signs and Labels |

| | |
|---|---|
| NEMA 250 | (2008) Enclosures for Electrical Equipment (1000 Volts Maximum) |
| NEMA FU 1 | (2002; R 2007) Low Voltage Cartridge Fuses |
| NEMA ICS 1 | (2000; R 2005; R 2008) Standard for Industrial Control and Systems: General Requirements |
| NEMA ICS 2 | (2000; R 2005; Errata 2008) Standard for Controllers, Contactors, and Overload Relays Rated 600 V |
| NEMA ICS 4 | (2005) Terminal Blocks |
| NEMA ICS 6 | (1993; R 2011) Enclosures |
| NEMA KS 1 | (2001; R 2006) Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum) |
| NEMA RN 1 | (2005) Standard for Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit |
| NEMA TC 2 | (2003) Standard for Electrical Polyvinyl Chloride (PVC) Conduit |
| NEMA TC 3 | (2004) Standard for Polyvinyl Chloride (PVC) Fittings for Use With Rigid PVC Conduit and Tubing |
| NEMA WD 1 | (1999; R 2005) Standard for General Color Requirements for Wiring Devices |
| NEMA WD 6 | (2002; R 2008) Dimensions for Wiring Devices |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 70 | (2014; AMD 1 2013; Errata 1 2013; AMD 2 2013; Errata 2 2013; AMD 3 2014; Errata 3 2014) National Electrical Code |
| NFPA 70E | (2009; Errata 09-1) Standard for Electrical Safety in the Workplace |
| NFPA 780 | (2008) Standard for the Installation of Lightning Protection Systems |

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

| | |
|---|---|
| TIA J-STD-607-A | (2002) Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications |
| TIA/EIA-569-A | (1998; Addenda 2000, 2001) Commercial Building Standards for Telecommunications Pathways and Spaces |

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

| | |
|---|---|
| 29 CFR 1910.147 | Control of Hazardous Energy (Lock Out/Tag Out) |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 1 | (2005; R 2003 thru 2007) Standard for Flexible Metal Conduit |
| UL 1010 | (2006) Standard for Receptacle-Plug Combinations for Use in Hazardous (Classified) Locations |
| UL 1063 | (2006) Standard for Machine-Tool Wires and Cables |
| UL 1242 | (2006; Reprint Jul 2012) Standard for Electrical Intermediate Metal Conduit -- Steel |
| UL 1449 | (2006; R 1998 thru 2009) Standard for Surge Protective Devices |
| UL 198M | (2003; R 2007) Standard for Mine-Duty Fuses |
| UL 20 | (2000; R 2002 thru 2008) General-Use Snap Switches |
| UL 360 | (2009; R 2009) Standard for Liquid-Tight Flexible Steel Conduit |
| UL 44 | (2005; R 2005) Thermoset-Insulated Wires and Cables |
| UL 467 | (2007) Grounding and Bonding Equipment |
| UL 486A-486B | (2003; R 2004 thru 2009) Standard for Wire Connectors |
| UL 486C | (2004; R 2009) Splicing Wire Connectors |
| UL 489 | (2013) Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures |

| | |
|---|---|
| UL 498 | (2001; R 2002 thru 2009) Standard for Attachment Plugs and Receptacles |
| UL 50 | (2007) Enclosures for Electrical Equipment, Non-environmental Considerations |
| UL 506 | (2008; R 2009) Standard for Specialty Transformers |
| UL 508 | (1999; Reprint Oct 2013) Industrial Control Equipment |
| UL 510 | (2005; R 2008) Standard for Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape |
| UL 512 | (1993; R 1993 thru 2008) Standard for Fuseholders |
| UL 514A | (2004; R 2005 thru 2009) Metallic Outlet Boxes |
| UL 514B | (2004; R 2006 thru 2009) Conduit, Tubing and Cable Fittings |
| UL 514C | (1996; R 1998 thru 2009) Standard for Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers |
| UL 6 | (2007; reprint Nov 2010) Electrical Rigid Metal Conduit-Steel |
| UL 651 | (2005; R 2006 thru 2008) Standard for Schedule 40 and 80 Rigid PVC Conduit and Fittings |
| UL 67 | (2009) Standard for Panelboards |
| UL 674 | (2003; R 2006 thru 2008) Standard for Electric Motors and Generators for Use in Division 1 Hazardous (Classified) Locations |
| UL 698 | (2006) Standard for Industrial Control Equipment for Hazardous (Classified) Locations |
| UL 6A | (2008) Electrical Rigid Metal Conduit - Aluminum, Red Brass, and Stainless Steel |
| UL 797 | (2007) Electrical Metallic Tubing -- Steel |
| UL 817 | (2001; R 2003 thru 2009) Standard for Cord Sets and Power-Supply Cords |

| | |
|---|---|
| UL 83 | (2008) Thermoplastic-Insulated Wires and Cables |
| UL 869A | (2006) Reference Standard for Service Equipment |
| UL 877 | (1993; R 1996 thru 2009) Standard for Circuit Breakers and Circuit-Breaker Enclosures for Use in Hazardous (Classified) Locations |
| UL 886 | (1994; R 1994 thru 2005) Standard for Outlet Boxes and Fittings for Use in Hazardous (Classified) Locations |
| UL 943 | (2006; R 2008) Ground-Fault Circuit-Interrupters |

1.2 DEFINITIONS

Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, shall be as defined in IEEE 100.

1.3 SUBMITTALS

Contracting Officer's written approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Panelboards

Include wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure a coordinated installation. Wiring diagrams shall identify circuit terminals and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Drawings shall indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices.

Wireways

Marking strips drawings

SD-03 Product Data

Receptacles

Circuit breakers

Switches

Enclosed circuit breakers

Motor controllers

Manual motor starters

Surge protective devices

Submittals shall include performance and characteristic curves.

SD-06 Test Reports

600-volt wiring test

Grounding system test

Ground-fault receptacle test

SD-07 Certificates

Fuses

SD-10 Operation and Maintenance Data

Electrical Systems

Submit operation and maintenance data in accordance with Section 01 78 23 OPERATING INSTRUCTIONS AND TRAINGING and as specified herein.

## 1.4 QUALITY ASSURANCE

### 1.4.1 Fuses

Submit coordination data as specified in paragraph, FUSES of this section.

### 1.4.2 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

### 1.4.3 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

#### 1.4.3.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

#### 1.4.3.2 Material and Equipment Manufacturing Date

Products manufactured more than 3 years prior to date of delivery to site shall not be used, unless specified otherwise.

### 1.4.4 Coordination

Provide all necessary equipment, raceway, circuitry, fittings, lugs, terminations, labor, etc. and connect to all equipment and appliances requiring electrical connections furnished herein, by the Government, or by other Contractors. Prior to ordering electrical equipment and roughing in for equipment furnished herein, by the Government, or by other Contractors, verify all connection types, connection locations, connection heights, voltages, number of phases, conductor sizes, disconnecting means, breaker sizes, etc. Furnish the proper electrical equipment for the equipment actually being supplied.

## 1.5 MAINTENANCE

### 1.5.1 Electrical Systems

Submit operation and maintenance manuals for electrical systems that provide basic data relating to the design, operation, and maintenance of the electrical distribution system for the building. This shall include:

a. Single line diagram of the "as-built" building electrical system.

b. Schematic diagram of electrical control system (other than HVAC, covered elsewhere).

c. Manufacturers' operating and maintenance manuals on active electrical equipment.

## 1.6 WARRANTY

The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

# PART 2 PRODUCTS

## 2.1 MATERIALS AND EQUIPMENT

Materials, equipment, and devices shall, as a minimum, meet requirements of UL, where UL standards are established for those items, and requirements of NFPA 70.

## 2.2 CONDUIT AND FITTINGS

Shall conform to the following:

### 2.2.1 Rigid Metallic Conduit

#### 2.2.1.1 Rigid, Threaded Zinc-Coated Steel Conduit

ANSI C80.1, UL 6.

#### 2.2.1.2 Rigid Aluminum Conduit

ANSI C80.5, UL 6A.

### 2.2.2 Rigid Nonmetallic Conduit

PVC Type EPC-80 in accordance with NEMA TC 2, UL 651.

### 2.2.3 Intermediate Metal Conduit (IMC)

UL 1242, zinc-coated steel only.

### 2.2.4 Electrical, Zinc-Coated Steel Metallic Tubing (EMT)

UL 797, ANSI C80.3.

### 2.2.5 Plastic-Coated Rigid Steel and IMC Conduit

NEMA RN 1, Type 40 (40 mils thick).

### 2.2.6 Flexible Metal Conduit

UL 1.

2.2.6.1 Liquid-Tight Flexible Metal Conduit, Steel

UL 360.

2.2.7 Fittings for Metal Conduit, EMT, and Flexible Metal Conduit

UL 514B. Ferrous fittings shall be cadmium- or zinc-coated in accordance with UL 514B.

2.2.7.1 Fittings for Rigid Metal Conduit and IMC

Threaded-type. Split couplings unacceptable.

2.2.7.2 Fittings for EMT

Steel compression type.

2.2.8 Fittings for Rigid Nonmetallic Conduit

NEMA TC 3 for PVC, and UL 514B.

2.3 OUTLET BOXES AND COVERS

UL 514A, cadmium- or zinc-coated, if ferrous metal. UL 514C, if nonmetallic.

2.4 CABINETS, JUNCTION BOXES, AND PULL BOXES

Volume greater than 100 cubic inches, UL 50, hot-dip, zinc-coated, if sheet steel.

2.5 WIRES AND CABLES

Wires and cables shall meet applicable requirements of NFPA 70 and UL for type of insulation, jacket, and conductor specified or indicated. Wires and cables manufactured more than 12 months prior to date of delivery to site shall not be used.

2.5.1 Conductors

Conductors No. 8 AWG and larger diameter shall be stranded. Conductors No. 10 AWG and smaller diameter shall be solid, except that conductors for remote control, alarm, and signal circuits, classes 1, 2, and 3, shall be stranded unless specifically indicated otherwise. Conductor sizes and capacities shown are based on copper, unless indicated otherwise. All conductors shall be copper.

2.5.1.1 Minimum Conductor Sizes

Minimum size for branch circuits shall be No. 12 AWG; for Class 1 remote-control and signal circuits, No. 14 AWG; for Class 2 low-energy, remote-control and signal circuits, No. 16 AWG; and for Class 3 low-energy, remote-control, alarm and signal circuits, No. 22 AWG.

2.5.2 Color Coding

Provide for service, feeder, branch, control, and signaling circuit conductors. Color shall be green for grounding conductors and white for neutrals; except where neutrals of more than one system are installed in same raceway or box, other neutrals shall be white with a different colored (not green) stripe for each. Color of ungrounded conductors in different voltage systems shall be as follows:

a. 208/120 volt, three-phase

(1) Phase A - black

(2) Phase B - red

(3) Phase C - blue

2.5.3 Insulation

Unless specified or indicated otherwise or required by NFPA 70, power and lighting wires shall be 600-volt, Type THWN/THHN conforming to UL 83 where run in dry locations, use Type XHHW conforming to UL 44 in wet locations. Grounding wire may be type TW conforming to UL 83; remote-control and signal circuits shall be Type TW or TF, conforming to UL 83. Where lighting fixtures require 90-degree Centigrade (C) conductors, provide only conductors with 90-degree C insulation or better.

2.5.4 Bonding Conductors

ASTM B 1, solid bare copper wire for sizes No. 8 AWG and smaller diameter; ASTM B 8, Class B, stranded bare copper wire for sizes No. 6 AWG and larger diameter.

2.5.4.1 Telecommunications Bonding Backbone (TBB)

Provide a copper conductor TBB in accordance with TIA J-STD-607-A. The TBB shall be a minimum No. 1/0 AWG.

2.5.4.2 Bonding Conductor for Telecommunications

Provide a copper conductor Bonding Conductor for Telecommunications between the telecommunications main grounding busbar (TMGB) and the electrical service ground in accordance with TIA J-STD-607-A. The bonding conductor for telecommunications shall be sized the same as the TBB.

2.5.5 Cord Sets and Power-Supply Cords

UL 817.

2.6 SPLICES AND TERMINATION COMPONENTS

UL 486A-486B for wire connectors and UL 510 for insulating tapes. Connectors for No. 10 AWG and smaller diameter wires shall be insulated, pressure-type in accordance with UL 486A-486B or UL 486C (twist-on splicing connector). Provide solderless terminal lugs on stranded conductors.

2.7 DEVICE PLATES

Provide UL listed, one-piece device plates for outlets to suit the devices installed. For metal outlet boxes, plates on unfinished walls shall be of zinc-coated sheet steel or cast metal having round or beveled edges. Plates on finished walls shall be satin finish stainless steel or brushed-finish aluminum, minimum 0.03 inch thick. Screws shall be machine-type with countersunk heads in color to match finish of plate. Sectional type device plates will not be permitted. Plates installed in wet locations shall be gasketed and UL listed for "wet locations."

2.8 SWITCHES

2.8.1 Toggle Switches

NEMA WD 1, UL 20, single pole, double pole, three-way, and four-way, totally enclosed with bodies of thermoplastic or thermoset plastic and mounting strap with grounding screw. Handles shall be thermoplastic of color selected by the Contracting Officer’s Representative. Wiring terminals shall be screw-type, side-wired or of the solderless pressure type having suitable conductor-release arrangement. Contacts shall be silver-cadmium and contact arm shall be one-piece copper alloy. Switches shall be rated quiet-type ac only, 120/277 volts, with current rating and number of poles indicated.

2.8.2 Switch with Red Pilot Handle

NEMA WD 1. Provide pilot lights that are integrally constructed as a part of the switch's handle. The pilot light shall be red and shall illuminate whenever the switch is closed or "on". The pilot lighted switch shall be rated 20 amps and 120 volts or 277 volts as indicated. Provide the circuit's neutral conductor to each switch with a pilot light.

2.8.3 Breakers Used as Switches

For 120- and 277-Volt fluorescent fixtures, mark breakers "SWD" in accordance with UL 489.

2.8.4 Disconnect Switches

NEMA KS 1. Provide heavy duty-type switches where indicated, where switches are rated higher than 240 volts, and for double-throw switches. Fused switches shall utilize Class R fuseholders and fuses, unless indicated otherwise. Switches serving as motor-disconnect means shall be horsepower rated. Provide switches in NEMA 1 enclosure where installed indoors and NEMA 3R enclosure where installed outdoors per NEMA ICS 6. Use special enclosures where indicated on the drawings.

## 2.9 FUSES

NEMA FU 1. Provide complete set of fuses for each fusible switch. Time-current characteristics curves of fuses serving motors or connected in series with circuit breakers or other circuit protective devices shall be coordinated for proper operation. Submit coordination data for approval. Fuses shall have voltage rating not less than circuit voltage.

### 2.9.1 Fuseholders

Provide in accordance with UL 512.

### 2.9.2 Cartridge Fuses, Current Limiting Type (Class R)

UL 198M, Class RK-1 time-delay type. Associated fuseholders shall be Class R only.

### 2.9.3 Cartridge Fuses, High-Interrupting Capacity, Current Limiting Type (Classes J, L, and CC)

UL 198M, Class J for zero to 600 amperes, Class L for 601 to 6,000 amperes, and Class CC for zero to 30 amperes.

### 2.9.4 Cartridge Fuses, Current Limiting Type (Class T)

UL 198M, Class T for zero to 1,200 amperes, 300 volts; and zero to 800 amperes, 600 volts.

## 2.10 RECEPTACLES

UL 498, hard use, heavy-duty, grounding-type. Ratings and configurations shall be as indicated. Bodies shall be of color selected by the Contracting Officer as per NEMA WD 1. Face and body shall be thermoplastic supported on a metal mounting strap. Dimensional requirements shall be per NEMA WD 6. Provide screw-type, side-wired wiring terminals. Connect grounding pole to mounting strap. The receptacle shall contain triple-wipe power contacts and double or triple-wipe ground contacts.

### 2.10.1 Weatherproof Receptacles

Provide in cast metal box with gasketed, weatherproof, cast-metal cover plate and gasketed cap over each receptacle opening. Provide caps with a spring-hinged flap. Receptacle shall be UL listed for use in "wet locations with plug in use."

2.10.2 Ground-Fault Circuit Interrupter Receptacles

UL 943, duplex type for mounting in standard outlet box. Device shall be capable of detecting current leak of 6 milliamperes or greater and tripping per requirements of UL 943 for Class A GFCI devices. Provide screw-type, side-wired wiring terminals or pre-wired (pigtail) leads.

2.10.3 Special Purpose Receptacles

Receptacles indicated with other configurations shown shall be of industrial grade quality, and shall be furnished with appropriate flush mount boxes with brushed stainless steel wallplates.

2.10.4 Plugs

Provide heavy-duty, rubber-covered cord of required size, install plugs thereon, and attach to equipment. Plugs shall be UL listed with receptacles, complete with grounding blades. Where equipment is not available, turn over plugs and cord assemblies to the Government.

2.10.5 Tamper-Resistant Receptacles

Provide duplex receptacle with mechanical sliding shutters that prevent the insertion of small objects into its contact slots.

2.11 PANELBOARDS

UL 67 and UL 50 having a short-circuit current rating as indicated. Panelboards for use as service disconnecting means shall additionally conform to UL 869A. Panelboards shall be circuit breaker-equipped. Design shall be such that individual breakers can be removed without disturbing adjacent units or without loosening or removing supplemental insulation supplied as means of obtaining clearances as required by UL. "Specific breaker placement" is required in panelboards to match the breaker placement indicated in the panelboard schedule on the drawings. Use of "Subfeed Breakers" is not acceptable unless specifically indicated otherwise. Main breaker shall be "separately" mounted "above" or "below" branch breakers. Where "space only" is indicated, make provisions for future installation of breakers. Directories shall indicate load served by each circuit in panelboard. Directories shall also indicate source of service to panelboard (e.g., Panel PA served from Panel MDP). Type directories and mount in holder behind transparent protective covering. Panelboards shall be listed and labeled for their intended use. Panelboard shall have nameplates in accordance with paragraph FIELD FABRICATED NAMEPLATES.

2.11.1 Enclosure

Enclosures shall meet the requirements of UL 50. All cabinets shall be fabricated from sheet steel of not less than No. 10 gauge if flush-mounted or mounted outdoors, and not less than No. 12 gauge if surface-mounted indoors, with full seam-welded box ends. Cabinets mounted outdoors or flush-mounted shall be hot-dipped galvanized after fabrication. Cabinets shall be painted in accordance with paragraph PAINTING. Outdoor cabinets shall be of NEMA 4X

construction with conduit hubs welded to the cabinet. Front edges of cabinets shall be form-flanged or fitted with structural shapes welded or riveted to the sheet steel, for supporting the panelboard front. Panelboards shall be furnished with door-in-door construction. All cabinets shall be so fabricated that no part of any surface on the finished cabinet shall deviate from a true plane by more than 1/8 inch. Holes shall be provided in the back of indoor surface-mounted cabinets, with outside spacers and inside stiffeners, for mounting the cabinets with a 1/2 inch clear space between the back of the cabinet and the wall surface. Flush doors shall be mounted on hinges that expose only the hinge roll to view when the door is closed. Each door shall be fitted with a combined catch and lock, except that doors over 24 inches long shall be provided with a three-point latch having a knob with a T-handle, and a cylinder lock. Two keys shall be provided with each lock, and all locks shall be keyed alike. Finished-head cap screws shall be provided for mounting the panelboard fronts on the cabinets.

2.11.2 Panelboard Buses

All panelboard buses shall be copper or tin-plated copper. Support bus bars on bases independent of circuit breakers. Main buses and back pans shall be designed so that breakers may be changed without machining, drilling, or tapping. Provide isolated neutral bus in each panel for connection of circuit neutral conductors. Provide separate ground bus identified as equipment grounding bus per UL 67 for connecting grounding conductors; bond to steel cabinet.

2.11.3 Circuit Breakers

UL 489, thermal magnetic-type or solid state-type having a minimum short-circuit current rating equal to the short-circuit current rating of the panelboard in which the circuit breaker shall be mounted. Breaker terminals shall be UL listed as suitable for type of conductor provided. Where indicated on the drawings, provide circuit breakers with shunt trip devices. Series rated circuit breakers and plug-in circuit breakers are unacceptable.

2.11.3.1 Multipole Breakers

Provide common trip-type with single operating handle. Breaker design shall be such that overload in one pole automatically causes all poles to open. Maintain phase sequence throughout each panel so that any three adjacent breaker poles are connected to Phases A, B, and C, respectively.

2.11.3.2 Circuit Breaker With GFCI

UL 943 and NFPA 70. Provide with "push-to-test" button, visible indication of tripped condition, and ability to detect and trip on current imbalance of 6 milliamperes or greater per requirements of UL 943 for Class A GFCI devices, for personnel protection, and 20 milliamperes or greater per requirements of UL 943 for Class B GFCI per equipment protection.

2.11.3.3 Circuit Breakers for HVAC Equipment

Circuit breakers for HVAC equipment having motors (group or individual) shall be marked for use with HACR type and UL listed as HACR type.

## 2.12 ENCLOSED CIRCUIT BREAKERS

UL 489. Individual molded case circuit breakers with voltage and continuous current ratings, number of poles, overload trip setting, and short circuit current interrupting rating as indicated. Enclosure type as indicated. Provide solid neutral.

## 2.13 MOTOR CONTROLLERS

UL 508, NEMA ICS 1, and NEMA ICS 2. Controllers shall have thermal overload protection in each phase and shall have one spare normally open and one spare normally closed auxiliary contact. Provide controllers for motors rated 1-hp and above with electronic phase-voltage monitors designed to protect motors from phase-loss, undervoltage, and overvoltage. Provide protection for motors from immediate restart by a time adjustable restart relay. Magnetic-type motor controllers shall have undervoltage protection when used with momentary-contact pushbutton stations or switches and shall have undervoltage release when used with maintained-contact pushbutton stations or switches. When used with pressure, float, or similar automatic-type or maintained-contact switch, controller shall have hand/off/automatic selector switch. Connections to selector switch shall be such that only normal automatic regulatory control devices are bypassed when switch is in "hand" position. Safety control devices, such as low and high pressure cutouts, high temperature cutouts, and motor overload protective devices, shall be connected in motor control circuit in "hand" and "automatic" positions. Control circuit connections to hand/off/automatic selector switch or to more than one automatic regulatory control device shall be made in accordance with indicated or manufacturer's approved wiring diagram. For each motor not in sight of controller or where controller disconnecting means is not in sight of motor location and driven machinery location, controller disconnecting means shall be capable of being locked in open position. As an alternative, provide a manually operated, lockable, nonfused switch which disconnects motor from supply source within sight of motor. Overload protective devices shall provide adequate protection to motor windings; be thermal inverse-time-limit type; and include manual reset-type pushbutton on outside of motor controller case. Cover of combination motor controller and manual switch or circuit breaker shall be interlocked with operating handle of switch or circuit breaker so that cover cannot be opened unless handle of switch or circuit breaker is in "off" position. Minimum short circuit withstand rating of combination motor controller shall be the same as the panelboard from which it is served. Provide controllers in hazardous locations with classifications as indicated.

### 2.13.1 Control Wiring

All control wire shall be stranded tinned copper switchboard wire with 600-volt flame-retardant insulation Type SIS meeting UL 44, or Type MTW meeting UL 1063, and shall pass the VW-1 flame tests included in those standards. Hinge wire shall have Class K stranding. Current transformer secondary leads shall be not smaller than No. 10 AWG. The minimum size of control wire shall be No. 14 AWG. Power wiring for 480-volt circuits and below shall be of the same type as control wiring and the minimum size shall be No. 12 AWG. Special attention shall

be given to wiring and terminal arrangement on the terminal blocks to permit the individual conductors of each external cable to be terminated on adjacent terminal points.

2.13.2 Control Circuit Terminal Blocks

NEMA ICS 4. Control circuit terminal blocks for control wiring shall be molded or fabricated type with barriers, rated not less than 600 volts. The terminals shall be removable binding, fillister or washer head screw type, or of the stud type with contact and locking nuts. The terminals shall be not less than No. 10 in size and shall have sufficient length and space for connecting at least two indented terminals for 10 AWG conductors to each terminal. The terminal arrangement shall be subject to the approval of the Contracting Officer's Representative and not less than four (4) spare terminals or 10 percent, whichever is greater, shall be provided on each block or group of blocks. Modular, pull apart, terminal blocks will be acceptable provided they are of the channel or rail-mounted type. The Contractor shall submit data showing that the proposed alternate will accommodate the specified number of wires, are of adequate current-carrying capacity, and are constructed to assure positive contact between current-carrying parts.

2.13.2.1 Types of Terminal Blocks

a. Short-Circuiting Type: Short-circuiting type terminal blocks shall be furnished for all current transformer secondary leads and shall have provision for shorting together all leads from each current transformer without first opening any circuit. Terminal blocks shall meet the requirements of paragraph CONTROL CIRCUIT TERMINAL BLOCKS above.

b. Load Type: Load terminal blocks rated not less than 600 volts and of adequate capacity shall be provided for the conductors for NEMA Size 3 and smaller motor controllers and for other power circuits, except those for feeder tap units. The terminals shall be of either the stud type with contact nuts and locking nuts or of the removable screw type, having length and space for at least two indented terminals of the size required on the conductors to be terminated. For conductors rated more than 50 amperes, screws shall have hexagonal heads. Conducting parts between connected terminals shall have adequate contact surface and cross-section to operate without overheating. Each connected terminal shall have the circuit designation or wire number placed on or near the terminal in permanent contrasting color.

2.13.3 Control Circuits

Control circuits shall have maximum voltage of 24 volts derived from control transformer in same enclosure. Transformers shall conform to UL 506, as applicable. Transformers, other than transformers in bridge circuits, shall have primaries wound for voltage available and secondaries wound for correct control circuit voltage. Size transformers so that 80 percent of rated capacity equals connected load. Provide disconnect switch on primary side. Provide fuses in each ungrounded primary feeder. One secondary lead shall be fused; other shall be grounded.

2.13.4 Enclosures for Motor Controllers

NEMA ICS 6.

2.13.5 Multiple-Speed Motor Controllers and Reversible Motor Controllers

Across-the-line-type, electrically and mechanically interlocked. Multiple-speed controllers shall have compelling relays and shall be multiple-button, station-type with pilot lights for each speed.

2.13.6 Pushbutton Stations

Provide with "start/stop" momentary contacts having one normally open and one normally closed set of contacts, and red lights to indicate when motor is running. Stations shall be heavy duty, oil-tight design.

2.13.7 Pilot and Indicating Lights

Provide LED cluster lamps.

2.14 MANUAL MOTOR STARTERS (MOTOR RATED SWITCHES)

Single, double or three pole as appropriate for the application designed for flush mounting with overload protection.

2.15 LOCKOUT REQUIREMENTS

Provide disconnecting means capable of being locked out for machines and other equipment to prevent unexpected startup or release of stored energy in accordance with 29 CFR 1910.147. Mechanical isolation of machines and other equipment shall be in accordance with requirements of Division 23, "Mechanical."

2.16 TELECOMMUNICATIONS SYSTEM

All outside plant pathways shall conform to the requirements of the ANSI/TIA-758-A Standard, the National Electrical Code (NEC), and the National Electrical Safety Code (NESC).

All OSP conduits shall have a minimum diameter of four inches. Where vehicular traffic is above the pathway all conduits shall be encased in concrete with a minimum 2500 $lb/in^2$ compressive strength and steel reinforcement.

Provide conduit, hand holes, and pull boxes IAW the ANSI/TIA-758 standard.
All conduit building penetrations shall be fire-stopped IAW the ANSI/TIA-569 standard. All conduit runs, whether empty or utilized, shall have nylon pull tape installed. Pull tape shall have footage markings and a 200-pound minimum pull strength. Pull tape shall be secured at each end of the conduit.

## 2.17 GROUNDING AND BONDING EQUIPMENT

### 2.17.1 Ground Rods

UL 467. Ground rods shall be copper-clad steel, with minimum diameter of 3/4 inch and minimum length of 10 feet.

### 2.17.2 Ground Bus

A copper ground bus shall be provided in the electrical equipment rooms as indicated.

## 2.18 HAZARDOUS LOCATIONS

Electrical materials, equipment, and devices for installation in hazardous locations, as defined by NFPA 70, shall be specifically approved by Underwriters' Laboratories, Inc., or Factory Mutual for particular "Class," "Division," and "Group" of hazardous locations involved. Boundaries and classifications of hazardous locations shall be as indicated. Equipment in hazardous locations shall comply with UL 877 for circuit breakers, UL 886 for outlet boxes and fittings, UL 1010 for receptacles, UL 674 for motors, and UL 698 for industrial controls.

## 2.19 MANUFACTURER'S NAMEPLATE

Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

## 2.20 FIELD FABRICATED NAMEPLATES

ASTM D 709. Provide laminated plastic nameplates for each equipment enclosure, relay, switch, and device; as specified or as indicated on the drawings. Each nameplate inscription shall identify the function and, when applicable, the position. Nameplates shall be melamine plastic, 0.125 inch thick, white with black center core. Surface shall be matte finish. Corners shall be square. Accurately align lettering and engrave into the core. Minimum size of nameplates shall be one by 2.5 inches. Lettering shall be a minimum of 0.25 inch high normal block style.

## 2.21 WARNING SIGNS

Provide warning signs for flash protection in accordance with NFPA 70E and ANSI Z535.4 for switchboards, panelboards, industrial control panels, and motor control centers that are in other than dwelling occupancies and are likely to require examination, adjustment, servicing, or maintenance while energized. Provide field installed signs to warn qualified persons of potential electric arc flash hazards when warning signs are not provided by the manufacturer. The marking shall be clearly visible to qualified persons before examination, adjustment, servicing, or maintenance of the equipment.

## 2.22 FIRESTOPPING MATERIALS

Provide firestopping around electrical penetrations.

## 2.23 WIREWAYS

Wireways, gutters, or electrical troughs shall not be used.

## 2.24 SURGE PROTECTIVE DEVICES

Provide parallel type surge protective devices which comply with UL 1449 at the service entrance, panelboard and downstream panelboards. Provide surge protectors in a NEMA 1 enclosure per NEMA ICS 6. Provide the following modes of protection:

FOR SINGLE PHASE AND THREE PHASE WYE CONNECTED SYSTEMS-
Each phase to neutral ( L-N )
Neutral to ground ( N-G )
Phase to ground ( L-G )

Surge protective devices at the service entrance shall have a minimum surge current rating of 80,000 amperes per mode minimum and downstream protectors shall be rated 40,000 amperes per mode minimum. The maximum line to neutral (L-N) Suppressed Voltage Rating (SVR) shall be:

500V for 208Y/120V, three phase system and

The minimum MCOV (Maximum Continuous Operating Voltage) rating shall be:

300/150V for 208Y/120V, three phase system and

EMI/RFI filtering shall be provided for each mode with the capability to attenuate high frequency noise. Minimum attenuation shall be 20db.

## 2.25 FACTORY APPLIED FINISH

Electrical equipment shall have factory-applied painting systems which shall, as a minimum, meet the requirements of NEMA 250 corrosion-resistance test and the additional requirements as specified herein. Interior and exterior steel surfaces of equipment enclosures shall be thoroughly cleaned and then receive a rust-inhibitive phosphatizing or equivalent treatment prior to painting. Exterior surfaces shall be free from holes, seams, dents, weld marks, loose scale or other imperfections. Interior surfaces shall receive not less than one coat of corrosion-resisting paint in accordance with the manufacturer's standard practice. Exterior surfaces shall be primed, filled where necessary, and given not less than two coats baked enamel with semigloss finish. Equipment located indoors shall be ANSI Light Gray, and equipment located outdoors shall be ANSI Light Gray. Provide manufacturer's coatings for touch-up work and as specified in paragraph FIELD APPLIED PAINTING.

## 2.26 COORDINATED POWER SYSTEM PROTECTION

Analyses shall be prepared as specified in Section 26 28 01 COORDINATED POWER SYSTEM PROTECTION.

# PART 3 EXECUTION

## 3.1 INSTALLATION

Electrical installations, including weatherproof and hazardous locations and ducts, plenums and other air-handling spaces, shall conform to requirements of NFPA 70 and IEEE C2 and to requirements specified herein.

### 3.1.1 Underground Service

Underground service conductors and associated conduit shall be continuous. Provide pull boxes as shown on the drawings.

### 3.1.2 Hazardous Locations

Work in hazardous locations, as defined by NFPA 70, shall be performed in strict accordance with NFPA 70 for particular "Class," "Division," and "Group" of hazardous locations involved. Provide conduit and cable seals where required by NFPA 70. Conduit shall have tapered threads.

### 3.1.3 Service Entrance Identification

Service entrance disconnect devices, switches, and enclosures shall be labeled and identified as such.

#### 3.1.3.1 Labels

Wherever work results in service entrance disconnect devices in more than one enclosure, as permitted by NFPA 70, each enclosure, new and existing, shall be labeled as one of several enclosures containing service entrance disconnect devices. Label, at minimum, shall indicate number of service disconnect devices housed by enclosure and shall indicate total number of enclosures that contain service disconnect devices. Provide laminated plastic labels conforming to paragraph FIELD FABRICATED NAMEPLATES. Use lettering of at least 0.25 inch in height, and engrave on black-on-white matte finish. Service entrance disconnect devices in more than one enclosure, shall be provided only as permitted by NFPA 70.

### 3.1.4 Wiring Methods

Provide insulated conductors installed in rigid steel conduit, IMC, rigid nonmetallic conduit, or EMT, except where specifically indicated or specified otherwise or required by NFPA 70 to be

installed otherwise. Grounding conductor shall be separate from electrical system neutral conductor. Provide insulated green equipment grounding conductor for circuit(s) installed in conduit and raceways. Minimum conduit size shall be 1/2 inch in diameter for low voltage lighting and power circuits. Conduit which penetrates fire-rated walls, fire-rated partitions, or fire-rated floors shall be firestopped.

3.1.4.1 Pull Wire

Install pull wires in empty conduits. Pull wire shall be plastic having minimum 200-pound force tensile strength unless otherwise noted. Leave minimum 36 inches of slack at each end of pull wire.

3.1.5 Conduit Installation

Unless indicated otherwise, conceal conduit within finished walls, ceilings, and floors. Keep conduit minimum 6 inches away from parallel runs of flues and steam or hot water pipes. Install conduit parallel with or at right angles to ceilings, walls, and structural members where located above accessible ceilings and where conduit will be visible after completion of project. Do not run conduits in or under slabs unless specifically indicated on the drawings. Route branch circuits and feeders overhead.

3.1.5.1 Restrictions Applicable to Aluminum Conduit

a. Do not install underground or encase in concrete or masonry.

b. Do not use brass or bronze fittings.

c. Do not use when the enclosed conductors must be shielded from the effects of High-altitude Electromagnetic Pulse (HEMP).

3.1.5.2 Restrictions Applicable to EMT

a. Do not install underground.

b. Do not encase in concrete, mortar, grout, or other cementitious materials.

c. Do not use in areas subject to severe physical damage including but not limited to equipment rooms where moving or replacing equipment could physically damage the EMT.

d. Do not use in hazardous areas.

e. Do not use outdoors.

f. Do not use in fire pump rooms.

g. Do not use when the enclosed conductors must be shielded from the effects of High-altitude Electromagnetic Pulse (HEMP).

3.1.5.3 Restrictions Applicable to Nonmetallic Conduit

a. PVC Schedule 80

(1) Do not use in areas where subject to severe physical damage, including but not limited to, mechanical equipment rooms, electrical equipment rooms, hospitals, power plants, missile magazines, and other such areas.

(2) Do not use in hazardous (classified) areas.

(3) Do not use in fire pump rooms.

(4) Do not use in penetrating fire-rated walls or partitions, or fire-rated floors.

(5) Do not use above grade.

(6) Do not use when the enclosed conductors must be shielded from the effects of High-altitude Electromagnetic Pulse (HEMP).

3.1.5.4 Restrictions Applicable to Flexible Conduit

Use only as specified in paragraph FLEXIBLE CONNECTIONS. Do not use when the enclosed conductors must be shielded from the effects of High-altitude Electromagnetic Pulse (HEMP).

3.1.5.5 Service Entrance Conduit, Underground

PVC, Type-EPC 80, galvanized rigid steel or steel IMC. Use PVC coated galvanized rigid steel elbows and PVC coated galvanized rigid steel for vertical runs. Underground portion shall be encased in minimum of 3 inches of concrete and shall be installed minimum 18 inches below slab or grade.

3.1.5.6 Underground Conduit Other Than Service Entrance

Plastic-coated rigid steel. Plastic coating shall extend minimum 6 inches above floor.

3.1.5.7 Conduit for Circuits Rated Greater Than 600 Volts

PVC-coated rigid metal conduit.

3.1.5.8 Conduit Installed Under Floor Slabs

Conduit run under floor slab shall be located a minimum of 12 inches below the vapor barrier. Seal around conduits at penetrations thru vapor barrier.

3.1.5.9 Conduit Through Floor Slabs

Where conduits rise through floor slabs, curved portion of bends shall not be visible above finished slab.

3.1.5.10 Conduit Support

Support conduit by pipe straps, wall brackets, hangers, or ceiling trapeze. Fasten by wood screws to wood; by toggle bolts on hollow masonry units; by concrete inserts or expansion bolts on concrete or brick; and by machine screws, welded threaded studs, or spring-tension clamps on steel work. Threaded C-clamps may be used on rigid steel conduit only. Do not weld conduits or pipe straps to steel structures. Load applied to fasteners shall not exceed one-fourth proof test load. Fasteners attached to concrete ceiling shall be vibration resistant and shock-resistant. Holes cut to depth of more than 1 1/2 inches in reinforced concrete beams or to depth of more than 3/4 inch in concrete joints shall not cut main reinforcing bars. Fill unused holes. In partitions of light steel construction, use sheet metal screws. In suspended-ceiling construction, run conduit above ceiling. Do not support conduit by ceiling support system or any types of hanger wires. Conduit and box systems shall be supported independently of both (a) tie wires supporting ceiling grid system, and (b) ceiling grid system into which ceiling panels are placed. Supporting means shall not be shared between electrical raceways and mechanical piping or ducts. Installation shall be coordinated with above-ceiling mechanical systems to assure maximum accessibility to all systems. Spring-steel fasteners shall not be used. Where conduit crosses building expansion joints, provide suitable watertight expansion fitting that maintains conduit electrical continuity by bonding jumpers or other means. For conduits greater than 2 1/2 inches inside diameter, provide supports to resist forces of 0.5 times the equipment weight in any direction and 1.5 times the equipment weight in the downward direction.

3.1.5.11 Directional Changes in Conduit Runs

Make changes in direction of runs with symmetrical bends or cast-metal fittings. Make field-made bends and offsets with hickey or conduit-bending machine. Do not install crushed or deformed conduits. Avoid trapped conduits. Prevent plaster, dirt, or trash from lodging in conduits, boxes, fittings, and equipment during construction. Free clogged conduits of obstructions.

3.1.5.12 Locknuts and Bushings

Fasten conduits to sheet metal boxes and cabinets with two locknuts where required by NFPA 70, where insulated bushings are used, and where bushings cannot be brought into firm contact with the box; otherwise, use at least minimum single locknut and bushing. Locknuts shall have sharp edges for digging into wall of metal enclosures. Install bushings on ends of conduits, and provide insulating type where required by NFPA 70.

3.1.5.13 Flexible Connections

Provide flexible steel conduit between 3 and 6 feet in length for recessed and semirecessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for motors. Install flexible conduit to allow 20 percent slack. Minimum flexible steel conduit size shall be 1/2 inch diameter. Provide liquid tight flexible metallic conduit in wet and damp locations for equipment subject to vibration, noise transmission, movement or motors. Provide separate ground conductor across flexible connections.

3.1.5.14 Telecommunications and Signal System Pathway

Install telecommunications pathway in accordance with TIA/EIA-569-A.

a. Backbone Pathway: Telecommunication pathways shall be installed in accordance with TIA/EIA-569-A. Size conduits for telecommunications risers in accordance with TIA/EIA-569-A and as indicated.

3.1.6 Boxes, Outlets, and Supports

Provide boxes in wiring and raceway systems wherever required for pulling of wires, making connections, and mounting of devices or fixtures. Boxes for metallic raceways shall be cast-metal, hub-type when located in wet locations, when surface mounted on outside of exterior surfaces, when surface mounted on interior walls exposed up to 7 feet above floors and walkways, or when installed in hazardous areas and when specifically indicated. Boxes in other locations shall be sheet steel, except that aluminum boxes may be used with aluminum conduit system. Each box shall have volume required by NFPA 70 for number of conductors enclosed in box. Boxes for mounting lighting fixtures shall be minimum 4 inches square, or octagonal, except that smaller boxes may be installed as required by fixture configurations, as approved. Boxes for use in masonry-block or tile walls shall be square-cornered, tile-type, or standard boxes having square-cornered, tile-type covers. Provide gaskets for cast-metal boxes installed in wet locations and boxes installed flush with outside of exterior surfaces. Provide separate boxes for flush or recessed fixtures when required by fixture terminal operating temperature; fixtures shall be readily removable for access to boxes unless ceiling access panels are provided. Support boxes and pendants for surface-mounted fixtures on suspended ceilings independently of ceiling supports. Fasten boxes and supports with wood screws on wood, with bolts and expansion shields on concrete or brick, with toggle bolts on hollow masonry units, and with machine screws or welded studs on steel. In open overhead spaces, cast boxes threaded to raceways need not be separately supported except where used for fixture support; support sheet metal boxes directly from building structure or by bar hangers. Where bar hangers are used, attach bar to raceways on opposite sides of box, and support raceway with approved-type fastener maximum 24 inches from box. When penetrating reinforced concrete members, avoid cutting reinforcing steel.

3.1.6.1 Boxes

Boxes for use with raceway systems shall be minimum 1 1/2 inches deep, except where shallower boxes required by structural conditions are approved. Boxes for other than lighting

fixture outlets shall be minimum 4 inches square, except that 4 by 2 inch boxes may be used where only one raceway enters outlet. Mount outlet boxes flush in finished walls.

3.1.6.2 Pull Boxes

Construct of at least minimum size required by NFPA 70 of code-gauge aluminum or galvanized sheet steel, except where cast-metal boxes are required in locations specified herein. Provide boxes with screw-fastened covers. Where several feeders pass through common pull box, tag feeders to indicate clearly electrical characteristics, circuit number, and panel designation.

3.1.6.3 Extension Rings

Extension rings are not permitted for new construction. Use only on existing boxes in concealed conduit systems where wall is furred out for new finish.

3.1.7 Mounting Heights

Mount panelboards, enclosed circuit breakers, motor controller and disconnecting switches so height of operating handle at its highest position is maximum 78 inches above floor. Mount lighting switches and handicapped telecommunications stations 48 inches above finished floor. Mount receptacles and telecommunications outlets 18 inches above finished floor, unless otherwise indicated. Mount other devices as indicated. Measure mounting heights of wiring devices and outlets in non-hazardous areas to center of device or outlet. Measure mounting heights of receptacle outlet boxes in hazardous areas to the bottom of the outlet box.

3.1.8 Conductor Identification

Provide conductor identification within each enclosure where tap, splice, or termination is made. For conductors No. 6 AWG and smaller diameter, color coding shall be by factory-applied, color-impregnated insulation. For conductors No. 4 AWG and larger diameter, color coding shall be by plastic-coated, self-sticking markers; colored nylon cable ties and plates; or heat shrink-type sleeves.

3.1.8.1 Marking Strips

White or other light-colored plastic marking strips, fastened by screws to each terminal block, shall be provided for wire designations. The wire numbers shall be made with permanent ink. The marking strips shall be reversible to permit marking both sides, or two marking strips shall be furnished with each block. Marking strips shall accommodate the two sets of wire numbers. Each device to which a connection is made shall be assigned a device designation in accordance with NEMA ICS 1 and each device terminal to which a connection is made shall be marked with a distinct terminal marking corresponding to the wire designation used on the Contractor's schematic and connection diagrams. The wire (terminal point) designations used on the Contractor's wiring diagrams and printed on terminal block marking strips may be according to the Contractor's standard practice; however, additional wire and cable designations for identification of remote (external) circuits shall be provided for the Government's wire

designations. Prints of the marking strips drawings submitted for approval will be so marked and returned to the Contractor for addition of the designations to the terminal strips and tracings, along with any rearrangement of points required.

3.1.9 Splices

Make splices in accessible locations. Make splices in conductors No. 10 AWG and smaller diameter with insulated, pressure-type connector. Make splices in conductors No. 8 AWG and larger diameter with solderless connector, and cover with insulation material equivalent to conductor insulation.

3.1.10 Covers and Device Plates

Install with edges in continuous contact with finished wall surfaces without use of mats or similar devices. Plaster fillings are not permitted. Install plates with alignment tolerance of 1/16 inch. Use of sectional-type device plates are not permitted. Provide gasket for plates installed in wet locations.

3.1.11 Electrical Penetrations

Seal openings around electrical penetrations through fire resistance-rated walls, partitions, floors, or ceilings.

3.1.12 Grounding and Bonding

Provide In accordance with NFPA 70 and NFPA 780. Ground exposed, non-current-carrying metallic parts of electrical equipment, metallic raceway systems, grounding conductor in metallic and nonmetallic raceways, telecommunications system grounds, and neutral conductor of wiring systems. Make ground connection at main service equipment, and extend grounding conductor to point of entrance of metallic water service. Make connection to water pipe by suitable ground clamp or lug connection to plugged tee. If flanged pipes are encountered, make connection with lug bolted to street side of flanged connection. Supplement metallic water service grounding system with additional made electrode in compliance with NFPA 70. Make ground connection to driven ground rods on exterior of building. Interconnect all grounding media in or on the structure to provide a common ground potential. This shall include lightning protection, electrical service, telecommunications system grounds, as well as underground metallic piping systems. Interconnection to the gas line shall be made on the customer's side of the meter. Use main size lightning conductors for interconnecting these grounding systems to the lightning protection system. In addition to the requirements specified herein, provide telecommunications grounding in accordance with TIA J-STD-607-A. Where ground fault protection is employed, ensure that connection of ground and neutral does not interfere with correct operation of fault protection.

3.1.12.1 Ground Rods

Provide cone pointed ground rods. The resistance to ground shall be measured using the fall-of-potential method described in IEEE 81. The maximum resistance of a driven ground shall not exceed 25 ohms under normally dry conditions. If this resistance cannot be obtained with a single rod, two additional rods not less than 6 feet on centers, or if sectional type rods are used, four additional sections may be coupled and driven with the first rod. In high-ground-resistance, UL listed chemically charged ground rods may be used. If the resultant resistance exceeds 25 ohms measured not less than 48 hours after rainfall, notify the Contracting Officer's Representative who will decide on the number of ground rods to add.

3.1.12.2 Grounding Connections

Make grounding connections which are buried or otherwise normally inaccessible, excepting specifically those connections for which access for periodic testing is required, by exothermic weld or compression connector.

a. Make exothermic welds strictly in accordance with the weld manufacturer's written recommendations. Welds which are "puffed up" or which show convex surfaces indicating improper cleaning are not acceptable. Mechanical connectors are not required at exothermic welds.

b. Make compression connections using a hydraulic compression tool to provide the correct circumferential pressure. Tools and dies shall be as recommended by the manufacturer. An embossing die code or other standard method shall provide visible indication that a connector has been adequately compressed on the ground wire.

3.1.12.3 Ground Bus

A copper ground bus shall be provided in the electrical equipment rooms as indicated. Noncurrent-carrying metal parts of equipment shall be effectively grounded by bonding to the ground bus. The ground bus shall be bonded to both the entrance ground, and to a ground rod or rods as specified above having the upper ends terminating approximately 4 inches above the floor. Connections and splices shall be of the brazed, welded, bolted, or pressure-connector type, except that pressure connectors or bolted connections shall be used for connections to removable equipment. Connections shall be bolted type in lieu of thermoweld, so they can be changed as required by additions and/or alterations.

3.1.12.4 Resistance

Maximum resistance-to-ground of grounding system shall not exceed 5 ohms under dry conditions. Where resistance obtained exceeds 5 ohms, contact Contracting Officer for further instructions.

3.1.13 Equipment Connections

Provide power wiring for the connection of motors and control equipment under this section of the specification. Except as otherwise specifically noted or specified, automatic control wiring,

control devices, and protective devices within the control circuitry are not included in this section of the specifications but shall be provided under the section specifying the associated equipment.

3.1.14 Government-Furnished Equipment

Contractor shall rough-in for Government-furnished equipment to make equipment operate as intended, including providing miscellaneous items such as plugs, receptacles, wire, cable, conduit, flexible conduit, and outlet boxes or fittings.

3.1.15 Surge Protective Devices

Connect the surge protective devices in parallel to the power source, keeping the conductors as short and straight as practically possible.

3.2 FIELD FABRICATED NAMEPLATE MOUNTING

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

3.3 WARNING SIGN MOUNTING

Provide the number of signs required to be readable from each accessible side. Space the signs in accordance with NFPA 70E.

3.4 FIELD APPLIED PAINTING

Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Painting shall be as specified in Section 09 90 00, PAINTS AND COATINGS. Where field painting of enclosures for panelboards, load centers or the like is specified to match adjacent surfaces, to correct damage to the manufacturer's factory applied coatings, or to meet the indicated or specified safety criteria, provide manufacturer's recommended coatings and apply in accordance to manufacturer's instructions.

3.5 FIELD QUALITY CONTROL

Furnish test equipment and personnel and submit written copies of test results. Give Contracting Officer’s Representative 5 working days notice prior to each test.

3.5.1 Devices Subject to Manual Operation

Each device subject to manual operation shall be operated at least five times, demonstrating satisfactory operation each time.

3.5.2 600-Volt Wiring Test

Test wiring rated 600 volt and less to verify that no short circuits or accidental grounds exist. Perform insulation resistance tests on wiring No. 6 AWG and larger diameter using instrument which applies voltage of approximately 500 volts to provide direct reading of resistance. Minimum resistance shall be 250,000 ohms.

3.5.3 Ground-Fault Receptacle Test

Test ground-fault receptacles with a "load" (such as a plug in light) to verify that the "line" and "load" leads are not reversed.

3.5.4 Grounding System Test

Test grounding system to ensure continuity, and that resistance to ground is not excessive. Test each ground rod for resistance to ground before making connections to rod; tie grounding system together and test for resistance to ground. Make resistance measurements in dry weather, not earlier than 48 hours after rainfall. Submit written results of each test to Contracting Officer, and indicate location of rods as well as resistance and soil conditions at time measurements were made.

-- End of Section 26 20 00 --

SECTION 26 28 01
COORDINATED POWER SYSTEM PROTECTION

PART 1 GENERAL

1.1 REFERENCES

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

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

| | |
|---|---|
| IEEE 242 | (2001; Errata 2003) Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems - Buff Book |
| IEEE 399 | (1997) Brown Book IEEE Recommended Practice for Power Systems Analysis |
| IEEE C2 | (2012; Errata 2012; INT 1-4 2012; INT 5-7 2013) National Electrical Safety Code |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 70 | (2014; AMD 1 2013; Errata 1 2013; AMD 2 2013; Errata 2 2013; AMD 3 2014; Errata 3 2014) National Electrical Code |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 489 | (2013) Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures |

1.2 SYSTEM DESCRIPTION

The power system covered by this specification consists of a 208Y/120V, 3 phase, 4 wire system originating in a utility company owned pad mounted transformer.

1.3 SUBMITTALS

Contracting Officer's written approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Fault Current Analysis

Protective Device Coordination Study

The study along with protective device equipment submittals. No time extensions or similar contact modifications will be granted for work arising out of the requirements for this study. Approval of protective devices proposed will be based on recommendations of this study. The Government shall not be held responsible for any changes to equipment, device ratings, settings, or additional labor for installation of equipment or devices ordered and/or procured prior to approval of the study.

Equipment

Data consisting of manufacturer's time-current characteristic curves for individual protective devices, recommended settings of adjustable protective devices, and recommended ratings of non-adjustable protective devices.

System Coordinator

Verification of experience and license number, of a registered Professional Engineer with at least 10 years of current experience in the design of coordinated power system protection. Experience data shall include at least five references for work of a magnitude comparable to this contract, including points of contact, addresses and telephone numbers. This engineer must perform items required by this section to be performed by a registered Professional Engineer.

Installation

Procedures including diagrams, instructions, and precautions required to properly install, adjust, calibrate, and test the devices and equipment.

SD-06 Test Reports

Field Testing

The proposed test plan, prior to field tests, consisting of complete field test procedure including tests to be performed, test equipment required, and tolerance limits, including complete testing and verification of the ground fault protection equipment, where used. Performance test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. Each test report shall indicate the final position of controls.

SD-07 Certificates

Devices and Equipment

Certificates certifying that all devices or equipment meet the requirements of the contract documents.

## 1.4 QUALITY ASSURANCE

### 1.4.1 System Coordinator

System coordination, recommended ratings and settings of protective devices, and design analysis shall be accomplished by a registered professional electrical power engineer with a minimum of 10 years of current experience in the coordination of electrical power systems.

### 1.4.2 System Installer

Calibration, testing, adjustment, and placing into service of the protective devices shall be accomplished by a manufacturer's product field service engineer or independent testing company with a minimum of two years of current product experience in protective devices.

## 1.5 DELIVERY, STORAGE, AND HANDLING

Devices and equipment shall be visually inspected when received and prior to acceptance from conveyance. Protect stored items from the environment in accordance with the manufacturer's published instructions. Damaged items shall be replaced.

## 1.6 PROJECT/SITE CONDITIONS

Devices and equipment furnished under this section shall be suitable for the following site conditions.

a. Altitude: 100 feet

b. Ambient Temperature: 100 degrees F

c. Frequency: 60 Hz

d. Humidity Control: 95 percent

# PART 2 PRODUCTS

## 2.1 STANDARD PRODUCT

Provide protective devices and equipment which are the standard product of a manufacturer regularly engaged in the manufacture of the product and that essentially duplicate items that have been in satisfactory utility type use for at least two years prior to bid opening.

## 2.2 NAMEPLATES

Provide nameplates to identify all protective devices and equipment. Nameplate information shall be in accordance with UL 489.

## 2.3 CORROSION PROTECTION

Metallic materials shall be protected against corrosion. Ferrous metal hardware shall be zinc or chrome-plated.

## 2.4 COORDINATED POWER SYSTEM PROTECTION

Analyses shall be prepared to demonstrate that the equipment selected and system constructed meet the contract requirements for ratings, coordination, and protection. They shall include a load flow analysis, a fault current analysis, a protective device coordination study and an arc flash hazard analysis. The studies shall be performed by a registered professional engineer with demonstrated experience in power system coordination in the last 10 years. Provide a list of references complete with points of contact, addresses and telephone numbers. The selection of the engineer is subject to the approval of the Contracting Officer.

### 2.4.1 Scope of Analyses

The fault current analysis, and protective device coordination study shall begin at: the source bus and extend down to system buses where fault availability is 10,000 amperes (symmetrical) for building/facility 600 volt level distribution buses. The arc flash hazard analysis shall extend to all equipment with an incident energy level of 1.2 cal/cm squared.

### 2.4.2 Determination of Facts

The time-current characteristics, features, and nameplate data for each existing protective device shall be determined and documented. Coordinate with the commercial power company for fault current availability at the site.

### 2.4.3 Single Line Diagram

A single line diagram shall be prepared to show the electrical system buses, devices, transformation points, and all sources of fault current (including generator and motor contributions). A fault-impedance diagram or a computer analysis diagram may be provided. Each bus, device or transformation point shall have a unique identifier. If a fault-impedance diagram is provided, impedance data shall be shown. Location of switches, breakers, and circuit interrupting devices shall be shown on the diagram together with available fault data, and the device interrupting rating.

### 2.4.4 Fault Current Analysis

#### 2.4.4.1 Method

The fault current analysis shall be performed in accordance with methods described in IEEE 242, and IEEE 399.

2.4.4.2 Data

Actual data shall be utilized in fault calculations. Bus characteristics and transformer impedance shall be those proposed. Data shall be documented in the report.

2.4.4.3 Fault Current Availability

Balanced three-phase fault, bolted line-to-line fault, and line-to-ground fault current values shall be provided at each voltage transformation point and at each power distribution bus. The maximum and minimum values of fault available at each location shall be shown in tabular form on the diagram or in the report.

2.4.5 Coordination Study

The study shall demonstrate that the maximum possible degree of selectivity has been obtained between devices specified, consistent with protection of equipment and conductors from damage from overloads and fault conditions. The study shall include a description of the coordination of the protective devices in this project. A written narrative shall be provided describing: which devices may operate in the event of a fault at each bus; the logic used to arrive at device ratings and settings; situations where system coordination is not achievable due to device limitations (an analysis of any device curves which overlap); coordination between upstream and downstream devices; and relay settings. Recommendations to improve or enhance system reliability, and detail where such changes would involve additions or modifications to the contract and cost damages (addition or reduction) shall be provided. Composite coordination plots shall be provided on log-log graph paper.

2.4.6 Study report

a. The report shall include a narrative describing: the analyses performed; the bases and methods used; and the desired method of coordinated protection of the power system.

b. The study shall include descriptive and technical data for existing devices and new protective devices proposed. The data shall include manufacturers published data, nameplate data, and definition of the fixed or adjustable features of the existing or new protective devices.

c. The report shall document utility company data including system voltages, fault MVA, system X/R ratio, time-current characteristic curves, current transformer ratios, and relay device numbers and settings.

d. The report shall contain fully coordinated composite time-current characteristics curves for each bus in the system, as required to ensure coordinated power system protection

between protective devices or equipment. The report shall include recommended ratings and settings of all protective devices in tabulated form.

e. The report shall provide the calculation performed for the analyses, including computer analysis programs utilized. The name of the software package, developer, and version number shall be provided.

## 2.5 ARC FLASH LABELS

Provide arc flash labels of the type shown on the drawings for all electrical equipment with an incident energy level of 1.2 cal/cm squared or greater, and all panelboards; regardless of incident energy level.

# PART 3 EXECUTION

## 3.1 EXAMINATION

After becoming familiar with details of the work, verify dimensions in the field, and advise the Contracting Officer's Representative of any discrepancy before performing any work.

## 3.2 INSTALLATION

Install protective devices in accordance with the manufacturer's published instructions and in accordance with the requirements of NFPA 70 and IEEE C2.

## 3.3 ARC FLASH LABELS

Install arc flash labels on all electrical equipment as required by the products section of this specification.

## 3.4 FIELD TESTING

### 3.4.1 General

Perform field testing in the presence of the Contracting Officer's Representative. Notify the Contracting Officer's Representative 5 days prior to conducting tests. Furnish all materials, labor, and equipment necessary to conduct field tests. Perform all tests and inspections recommended by the manufacturer unless specifically waived by the Contracting Officer. Maintain a written record of all tests which includes date, test performed, personnel involved, devices tested, serial number and name of test equipment, and test results.

### 3.4.2 Safety

Provide and use safety devices such as rubber gloves, protective barriers, and danger signs to protect and warn personnel in the test vicinity. Replace any devices or equipment which are damaged due to improper test procedures or handling.

### 3.4.3 Molded-Case Circuit Breakers

Circuit breakers shall be visually inspected, operated manually, and connections checked for tightness. Current ratings shall be verified and adjustable settings incorporated in accordance with the coordination study.

-- End of Section 26 28 01 --

SECTION 26 32 13
SINGLE OPERATION GENERATOR SETS

PART 1 GENERAL

1.1 REFERENCES

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

ASME INTERNATIONAL (ASME)

| | |
|---|---|
| ASME B16.1 | (2010) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250 |

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

| | |
|---|---|
| IEEE 115 | (2009) Guide for Test Procedures for Synchronous Machines: Part I Acceptance and Performance Testing; Part II Test Procedures and Parameter Determination for Dynamic Analysis |
| IEEE C2 | (2012; Errata 2012; INT 1-4 2012; INT 5-7 2013) National Electrical Safety Code |
| IEEE C50.12 | (2005; R 2010) Standard for Salient Pole 50 HZ and 60 Hz Synchronous Generators and Generation/Motors for Hydraulic Turbine Applications Rated 5 MVA and above |

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

| | |
|---|---|
| NETA ATS | (2013) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems |

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

| | |
|---|---|
| ISO 3046 | (1986; Am. 1) Reciprocating Internal Combustion Engines - Performance |
| ISO 8528 | (1993; R 2005) Reciprocating Internal Combustion Engine Driven Alternating Current Generator Sets |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| NEMA C50.10 | (1990) Rotating Electrical Machinery - Synchronous Machines |

| | |
|---|---|
| NEMA ICS 6 | (1993; R 2011) Enclosures |
| NEMA MG 1 | (2011; Errata 2012) Motors and Generators |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 30 | (2012; Errata 2011; Errata 2011) Flammable and Combustible Liquids Code |
| NFPA 37 | (2010; TIA 10-1; TIA 13-2; TIA 13-3) Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines |
| NFPA 70 | (2014; AMD 1 2013; Errata 1 2013; AMD 2 2013; Errata 2 2013; AMD 3 2014; Errata 3 2014) National Electrical Code |

U.S. DEPARTMENT OF DEFENSE (DOD)

| | |
|---|---|
| MIL-STD-461 | (2007; Rev F) Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment |

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

| | |
|---|---|
| CID A-A-52557 | (Rev A; Notice 1) Fuel Oil, Diesel; for Posts, Camps and Stations |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 1236 | (2006; Reprint Jul 2011) Standard for Battery Chargers for Charging Engine-Starter Batteries |
| UL 142 | (2006; Reprint Jul 2013) Steel Aboveground Tanks for Flammable and Combustible Liquids |
| UL 429 | (2013) Electrically Operated Valves |
| UL 467 | (2007) Grounding and Bonding Equipment |
| UL 489 | (2013) Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures |

1.2 RELATED REQUIREMENTS

Section 26 00 00 BASIC ELECTRICAL MATERIALS AND METHODS apply to this section except as modified herein.

## 1.3 SYSTEM DESCRIPTION

### 1.3.1 Engine-Generator Set Data

Submit data pertaining to the diesel engine-generator set and to the auxiliary equipment including but not limited to the following:

a. Make of engine.

b. Type or model of engine.

c. Gross bhp rating of engine shall be the total rated power output before deducting power requirements of electric motor-driven equipment or engine driven radiator fan.

d. Net brake power rating of engine shall include deductions for the total power requirements of electric motor-driven or engine-driven accessories as defined in ISO 3046. Net ratings shall include a deduction in power output for cooling media system power requirements including radiator fans and any other power consuming devices required to provide cooling as specified.

e. Strokes per cycle.

f. Number of cylinders.

g. Bore and stroke, inches.

h. Engine speed, rpm.

i. Piston speed, fpm.

j. kW power rating of engine-generator set as defined in the paragraph entitled "Engine-Generator Set Ratings and Performance."

k. Induction method (naturally aspirated, turbocharged).

l. Intercooler type (air-to-air or jacket water).

m. Governor type, make, and model.

n. Make and model of turbochargers.

### 1.3.2 Engine-Generator Set Efficiencies

Submit data pertaining to the diesel engine-generator set including but not limited to the following: Loads shall be calculated on basis of rated engine-generator set power.

a. Fuel consumption at 0.80 power factor, gallons per hr.

    1. 1/2 load

    2. 3/4 load

    3. Full load

b. Generator efficiency at 0.80 power factor (percent).

    1. 1/2 load

    2. 3/4 load

    3. Full load

c. Radiator capacity at design conditions.

    1. Coolant shall be antifreeze mixture as specified under paragraph entitled "Cooling System."

    2. gpm of coolant

    3. cfm of air through radiator

    4. Btu per hr of heat exchange based on optimum coolant temperature to and from engine.

1.3.3 Diesel Engine Data

Submit data certified by the engine manufacturer including but not limited to the following: Loads shall be calculated on basis of rated engine-generator set power.

a. Approximate exhaust temperature degrees F at full load

b. Weight of exhaust gas at full load lb per hr

c. Weight of intake air at full load lb per hr

d. Total heat rejected at full load Btu per hr

    1. To jacket coolant system

    2. To fuel oil cooling system

e. Emissions (Lbs/hr)(kg/hr) at full load

1. Total Suspended Particulate

2. Particulate matter with an average aerodynamic diameter of 10 microns (PM-10)

3. Sulfur dioxides

4. Nitrogen Oxides (as N02)

5. Carbon Monoxide

6. Volatile Organic Compounds

f. Visible Emissions (percent opacity) at full load

1.3.4 Generator and Exciter Data

Submit data certified by the generator manufacturer including but not limited to the following:

a. Make and model number of generator

b. kW rating of generator

c. Generator reactances

1. Synchronous reactance, Xd

2. Transient reactance, X'd

3. Subtransient reactance, X"d

4. Negative sequence reactance, X2

5. Zero sequence reactance, Xo

1.3.5 Calculations for Brake Mean Effective Pressure (BMEP)

Calculation shall verify that the diesel engine meets the specified maximum BMEP as follows:

a. kW: Minimum power rating of engine-generator set as defined in the paragraph entitled "Engine-Generator Set Ratings and Performance."

b. rpm: Engine revolutions per minute.

c. cu. in.: Total engine piston displacement in cubic inches.

d. GEN.EFF.: Generator efficiency.

e. x: Multiplication sign.

f. bhp': Brake horsepower required from diesel engine by generator loaded to full power rating.

g. bhp': kW/(GEN.EFF. times 0.746).

h. bhp": Brake horsepower required by diesel engine driven fan for cooling radiator or motor driven fan for cooling radiator.

i. bhp: bhp' plus bhp".

j. BMEP psi: (792,000 times bhp)
/(rpm times cu. in.).

1.3.6 Torsional Vibration Stress Analysis Computations

Torsional vibrational stresses in the crankshaft and generator shaft of assembled diesel engine and driven generator shall not exceed 5000 psi when engine is driving generator at rated speed while assembled unit is loaded to rated engine-generator set power. Computations shall be based on a mathematical model of the assembled generator set provided or based on calculations using measured values from tests on a unit identical to the one provided. Calculations based on models of, or measured data from, the unassembled engine and generator will not be acceptable. Calculations shall include:

a. A description of the system relating information pertinent to analysis such as operating speed range and identification plate data.

b. A mass elastic assembly drawing, showing the arrangement of the units in the generator set and dimensions of shafting, including minimum diameters (or section moduli) of shafting in the system.

c. A labeled line diagram of the mass elastic system indicating values of masses, stiffness, equivalent lengths, and equivalent diameters including basic assumptions and definition of terms.

d. Sample computations showing procedures used to obtain resulting stress values.

e. Computations indicating assembled engine-generator speed of 1800 rpm with assembly loaded to rated generator power and the resulting computed critical torsional stress values in the assembled engine crankshaft and generator shaft.

1.3.7 Capacity Calculations for Batteries

Calculation shall verify that the engine starting battery capacity exceeds dc power requirements.

1.4 SUBMITTALS

Contracting Officer's written approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Engine-Generator set and auxiliary equipment

SD-03 Product Data

Engine-generator set data

Engine-generator set efficiencies

Diesel engine data

Generator and exciter data

Diesel engine-generator set

SD-05 Design Data

Calculations for brake mean effective pressure

Torsional vibration stress analysis computations

Capacity calculations for batteries

SD-06 Test Reports

Acceptance checks and tests

Functional acceptance tests

Functional acceptance test procedure

SD-07 Certificates

Vibration isolation system certification

Fuel system certification

Start-up engineer qualification resume

Instructor's qualification resume

SD-09 Manufacturer's Field Reports

Engine tests

Generator tests

Assembled engine-generator set tests

SD-10 Operation and Maintenance Data

Diesel engine-generator set

Auxiliary systems and equipment

Preliminary assembled operation and maintenance manuals

Submit in accordance with Section 01 78 23 OPERATING INSTRUCTIONS AND TRAINGING and the paragraph entitled "Assembled Operation and Maintenance Manuals."

SD-11 Closeout Submittals

Posted operating instructions

Training plan

## 1.5 QUALITY ASSURANCE

### 1.5.1 Drawing Requirements

#### 1.5.1.1 Engine-Generator Set and Auxiliary Equipment

Submit drawings pertaining to the engine-generator set and auxiliary equipment, including but not limited to the following:

a. Certified outline, general arrangement (setting plan), and anchor bolt details. Show total weight and center of gravity of assembled equipment on the steel subbase.

b. Detailed elementary, schematic wiring, and interconnection diagrams of the engine starting system, jacket coolant heating system, engine protective devices, engine alarm devices, engine speed governor system, generator and excitation system, and other integral devices.

c. Detailed elementary, schematic wiring; and interconnection diagrams of the diesel fuel system, starting battery system, engine-generator control panel, generator circuit breaker.

d. Dimensional drawings or catalog cuts of exhaust silencers, radiator, diesel fuel day tanks, fuel oil cooler, valves and pumps, intake filters, vibration isolators, and other auxiliary equipment not integral with the engine-generator set.

1.5.2 Vibration Isolation System Certification

Submit certification from the manufacturer that the vibration isolation system will reduce the vibration to the limits specified in the paragraph entitled "Vibration Isolation System."

1.5.3 Fuel System Certification

When the diesel fuel system requires a fuel oil cooler as described in the paragraph entitled "Fuel Oil Cooler," submit certification from the engine manufacturer that the fuel system design is satisfactory.

1.6 DELIVERY, STORAGE, AND HANDLING

Deliver equipment on pallets or blocking wrapped in heavy-duty plastic, sealed to protect parts and assemblies from moisture and dirt. Plug piping, conduit, exhaust, and air intake openings. Protect and prepare batteries for shipment as recommended by the battery manufacturer. Store auxiliary equipment at the site in covered enclosures, protected from atmospheric moisture, dirt, and ground water.

1.7 SITE CONDITIONS

Protect the components of the engine-generator set, including cooling system components, pumps, fans, and similar auxiliaries when not operating and provide components capable of the specified outputs in the following environment:

a. a. Site Location: Station Hobucken, Hobucken, NC (Lat 35 14 50 N, Long 76 35 36 W)

b. Site Elevation: 4 feet above mean sea level.

c. Ambient Temperatures:

1. Maximum: 92 Degrees F dry bulb, 80 Degrees F wet bulb

2. Minimum: 20 Degrees F dry Bulb

d. Design Wind Velocity: knots.

e. Prevailing Wind Direction: N.

## 1.8 MAINTENANCE

### 1.8.1 Extra Materials

#### 1.8.1.1 Paint

Furnish one gallon of identical paint used on engine-generator set in manufacturer's sealed container with each engine-generator set.

#### 1.8.1.2 Filters

Furnish four spare replacement elements in their original containers for each filter with each unit.

### 1.8.2 Posted Operating Instructions

Provide proposed operating instructions for the engine-generator set and auxiliary equipment laminated between matte-surface thermoplastic sheets and suitable for placement adjacent to corresponding equipment. After approval, install operating instructions where directed.

# PART 2 PRODUCTS

## 2.1 DIESEL ENGINE-GENERATOR SET

Provide diesel engine-generator sets consisting of a water cooled diesel engine direct connected to an ac generator with a brushless excitation system and accessories. Equipment and materials shall be the manufacturer's standard products offered in catalogs for commercial or industrial use.

### 2.1.1 Engine-Generator Set Ratings and Performance

ISO 8528. Each engine-generator set shall have a power rating as shown on the drawings at 0.8 power factor and supply the voltage indicated on the drawings, three-phase, 60-Hz ac output. Coordinate the engine-generator set to ensure an installed rating in the environment described in paragraph entitled "Site Conditions." The power of the engine-generator set is defined as the power output available at the generator terminals excluding the electrical power absorbed by the essential independent auxiliaries. Essential independent auxiliaries are items of equipment which are essential for the continued or repeated operation of the engine which uses power supplied from a source other than the engine.

#### 2.1.1.1 Diesel Engine Capacity

The diesel engine shall meet the specified maximum BMEP requirements at rated speed as calculated in accordance with the paragraph entitled "Calculations for BMEP." The engine capacity shall be based on the following:

a. Engine burning diesel fuel conforming to CID A-A-52557, Grade DF-2 at an ambient temperature of 85 degrees F.

b. Engine cooled by a radiator fan mechanically driven by the diesel engine or remote with a motor driven fan.

c. Engine cooled by coolant mixture of water and ethylene glycol, 50 percent by volume of each.

Maximum BMEP, 1204 psi

| | Turbocharged |
|---|---|
| Four-cycle engines | 408 cu in |
| Engine speed, rpm: | 1800 |

2.1.1.2 Diesel Engine Emission Limits

The unit shall meet EPA Tier III requirements.

2.1.1.3 Performance Class

The voltage and frequency behavior of the generator set shall be in accordance with ISO 8528 operating limit values for performance Class G2.

2.1.2 Diesel Engines and Accessories

ISO 3046. Diesel engines shall be four-cycle naturally aspirated, or turbocharged, or turbocharged and intercooled; vertical in-line or vertical Vee type; designed for stationary service. Engines shall be capable of immediate acceleration from rest to normal speed without intermediate idle/warm up period or prelubrication to provide essential electrical power. Two-cycle engines are not acceptable.

2.1.2.1 Subbase Mounting

Mount each engine-generator set on a structural steel subbase sized to support the engine, generator, and necessary accessories, auxiliaries and control equipment to produce a complete self-contained unit as standard with the manufacturer. Design the structural subbase to properly support the equipment and maintain proper alignment of the engine-generator set in the specified seismic zone. In addition, provide subbase with both lifting rings and jacking pads properly located to facilitate shipping and installation of the unit. Factory align engine and generator on the subbase and securely bolt into place in accordance with the manufacturer's standard practice. Crankshaft shall have rigid coupling for connection to the generator.

2.1.2.2 Assembly

Completely shop assemble each engine-generator set on its structural steel subbase. Paint entire unit with manufacturer's standard paints and colors. After factory tests and before shipping, thoroughly clean and retouch painting as necessary to provide complete protection.

2.1.2.3 Turbocharger

If required by the manufacturer to meet the engine-generator set rating, provide turbine type driven by exhaust gas from engine cylinders, and direct connected to the blower supplying air to the engine intake manifold.

2.1.2.4 Intercooler

Provide manufacturer's standard intercooler for engine size specified.

2.1.2.5 Crankcase Protection

Provide manufacturer's standard method of preventing crankcase explosions and standard method of crankcase ventilation.

2.1.2.6 Engine Lubricating Oil System

Provide each engine with the manufacturer's standard full pressure lubricating oil system arranged to cool the pistons and to distribute oil to moving parts of the engine. Provide oil type and oil filters as recommended by the engine manufacturer.

2.1.2.7 Engine Cooling System

Provide each engine with the manufacturer's standard jacket water pump. Provide a thermostatic control valve in the jacket coolant system for each engine-generator set to maintain a constant jacket coolant temperature to the engine.

2.1.2.8 Engine Fuel System

Provide each engine with the manufacturer's standard fuel system integral with the engine, complete with necessary piping, fittings, and valves for connecting items of equipment which are a part of the system. Provide engine manufacturer's standard hand priming pump. Provide manufacturer's standard filter for each engine, of the throwaway filter element type, consisting of shell filter elements, drains, and necessary connections and fittings.

2.1.2.9 Engine Intake Filter

Provide intake filter assemblies for each engine of the oil bath or dry type, as standard with the manufacturer. Filters shall be capable of removing a minimum of 92 percent of dirt and abrasive

3 microns and larger from intake air. Size filters to suit engine requirements at 100 percent of rated full load. Design unit for field access for maintenance purposes.

2.1.2.10 Engine Starting System

Starting shall be accomplished using an adequately sized dc starter system with a positive shift solenoid to engage the starter motor and to crank the engine continuously for 60 seconds without overheating.

2.1.2.11 Jacket Coolant Heating System

Provide a factory-installed, jacket coolant heating system to ensure rapid starting. Thermostatically control heater at the temperature recommended by engine manufacturer. Include necessary equipment, piping, controls, wiring, and accessories.

2.1.2.12 Engine Protective (Shutdown) Devices

Equip each engine with devices to shut down the engine by shutting off the fuel supply to the engine via a fuel shutoff solenoid. Auxiliary contacts shall be suitable for activating a remote alarm system. Shutdown shall open the associated generator circuit breaker. Provide the following shutdown devices:

a. Overspeed device which operates when engine speed exceeds normal synchronous speed by 18 percent or as recommended by manufacturer. Device shall require manual reset.

b. Pressure switch which operates when lubricating oil pressure to engine drops below a preset value.

c. Temperature switch which operates when jacket coolant temperature exceeds a preset value.

d. Device which operates when the coolant level in the radiator drops below a preset level.

e. Other shutdown devices as recommended by the engine manufacturer.

2.1.2.13 Engine Alarm Devices

Equip each engine with alarm devices. Auxiliary contacts shall be suitable for activating a remote alarm system. Alarm devices shall have factory-fixed set points. Provide the following alarm contact devices:

a. Pressure switch which operates when lubricating oil pressure drops below a preset value.

b. Temperature switch which operates when jacket coolant temperature exceeds a preset value.

c. Temperature switch which operates when jacket coolant temperature is too low.

d. Other alarm devices as recommended by the engine manufacturer.

2.1.2.14 Miscellaneous Engine Accessories

Provide the following engine accessories where the manufacturer's standard design permits:

a. Piping on engine to inlet and outlet connections, including nonstandard companion flanges.

b. Structural steel subbase and vibration isolators, foundation bolts, nuts, and pipe sleeves.

c. Level jack screws or shims, as required.

d. Rails, chocks, and shims for installation of subbase on the foundation.

e. Removable guard, around fan. Support guard, on engine subbase, to suit manufacturer's standard.

2.1.2.15 Engine Speed Governor System

Provide a forward acting type engine speed governor system. Steady-state frequency band and frequency regulation (droop) shall be in accordance with the operating limit values of the performance class specified in the paragraph entitled "Performance Class."

2.1.3 Generator and Excitation System

2.1.3.1 Generator

Provide salient-pole type, ac, brushless-excited, revolving field, air-cooled, self-ventilated, coupled type, synchronous generator conforming to NEMA MG 1, Part 16, NEMA C50.10, and IEEE C50.12. Generator shall be rated for standby duty at 100 percent of the power rating of the engine-generator set as specified in paragraph entitled "Engine-Generator Set Ratings and Performance." Temperature rise of each of the various parts of the generator shall not exceed 130 degrees C as measured by resistance, based on a maximum ambient temperature of 40 degrees C. Winding insulation shall be Class H.

a. Stator: Stator windings shall be 2/3 pitch design 10-12 lead reconnectable.

b. Rotor: The rotor shall have connected amortiser windings.

c. Grounding: Provide non-corrosive steel grounding pads located at two opposite mounting legs.

d. Filters: Provide manufacturer's standard generator cooling air filter assembly.

2.1.3.2 Excitation System

Provide a brushless excitation system consisting of an exciter and rotating rectifier assembly, and permanent magnet generator integral with the generator and a voltage regulator. Insulation class for parts integral with the generator shall be as specified in paragraph entitled "Generator." System shall provide a minimum short circuit of 300 percent rated engine-generator set current for at least 10 seconds. Steady state voltage regulation shall be in accordance with the operating limit values of the performance class specified in the paragraph entitled "Performance Class."

a. Exciter and Rotating Rectifier Assembly: Rectifiers shall be provided with surge voltage protection.

b. Permanent Magnet Generator: Provide a voltage spike suppression device for permanent magnet generator (PMG) excitation systems.

c. Voltage Regulator: Voltage regulator shall be solid state or digital, automatic, three-phase sensing, volts per hertz type regulator. Regulator shall receive its input power from a PMG. Voltage variation for any 40 degree C change over the operating temperature range shall be less than plus or minus 1.0 percent. Operating temperature shall be minus 40 degree C to plus 70 degree C. Voltage adjust range shall be plus to minus 5.0 percent of nominal. Inherent regulator features shall include overexcitation shutdown.

2.1.3.3 Electromagnetic Interference (EMI) Suppression

Provide as an integral part of the generator and excitation system, EMI suppression complying with MIL-STD-461.

## 2.2 ENGINE-GENERATOR SET AUXILIARY SYSTEMS AND EQUIPMENT

Provide auxiliary systems and equipment designed for continuous duty at 100 percent of the power rating of the engine-generator set as specified in the paragraph entitled "Engine-Generator Set Ratings and Performance."

### 2.2.1 Vibration Isolation System

Install the subbase on vibration isolators that are secured to a suitable concrete foundation. Provide isolators as recommended by the engine-generator set and isolator manufacturers and provide integral or external lateral support to limit lateral movement and overturning moments. The isolation system shall reduce the vibration transmitted to the adjacent floor slab to a maximum of 0.0015 inch total amplitude throughout the frequency range down to 65 Hz.

### 2.2.2 Exhaust System

Provide exhaust systems for each engine.

2.2.2.1 Exhaust Silencers

A residential class silencer shall be provided for each engine which will reduce the exhaust sound spectrum by the following listed values at a 75 foot radius from the outlet, with generator set loaded to rated capacity and clear weather. Inlet and outlet connections shall be flanged.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Residental Class | 10 | 25 | 32 | 30 | 25 | 25 | 24 | 23 |

2.2.3 Cooling System

Provide the specified cooling water system. Properly size equipment to handle the flow rate and pressure losses of the coolant mixture specified in the paragraph entitled "Diesel Engine Capacity," and at the site elevation specified in the paragraph entitled "Site Conditions."

2.2.3.1 Radiators

Provide for each engine-generator set, as standard with the manufacturer.

a. Design Conditions: Each radiator unit shall have ample capacity to remove not less than the total Btu per hour of heat rejected by its respective engine at 100 percent full-rated load to the jacket water, fuel oil, and lubricating oil system, and intercooler. Radiator capacity shall be rated at optimum temperature of coolant leaving the engine and intercooler as recommended by the engine manufacturer with an ambient dry bulb air temperature outside the enclosure as specified in the paragraph entitled "Site Conditions," and with the coolant mixture specified in the paragraph entitled "Diesel Engine Capacity." Pressure drop through the radiator shall not exceed 6 psi when circulating the maximum required coolant flow. Radiator air velocity shall be a maximum of 1500 feet per minute.

b. Engine Mounted Radiator Construction: Radiator fan shall direct airflow from the engine outward through the radiator. Fan shall be V-belt driven directly from the engine crankshaft. Radiator fan shall have sufficient capacity to meet design conditions. Fan static capacity shall be adjusted to suit the ductwork furnished. Cooling section shall have a tube and fin-type core consisting of copper or copper base alloy tubes with nonferrous fins. Select engine-driven fans for quiet vibration-free operation. Make provision for coolant expansion either by self-contained expansion tanks or separately mounted expansion tanks, as standard with the manufacturer. Provide suitable guards for each fan and drive.

c. Coolant solution shall be a mixture of clean water and ethylene glycol, 50 percent by volume each. Provide an anti-freeze solution tester suitable for the mixture.

2.2.4 Diesel Fuel System

NFPA 30 and NFPA 37 and the requirements herein.

2.2.4.1 Diesel Fuel Piping System

Factory installed piping shall conform to the engine manufacturer's standard. Provide flange connections in accordance with ASME B16.1 Class 125 flanges.

2.2.4.2 Diesel Subbase Tank System

Provide diesel fuel subbase tank system. Include necessary equipment, piping, controls, wiring, and accessories.

a. Subbase Tanks: UL 142. Provide integral in skid double wall (110 percent containment) diesel fuel day tanks with a minimum capacity of 48 hours of engine-generator set operation at full-rated load. Epoxy coat day tanks inside and prime and paint outside. Construct tanks of not less than 3/16 inch steel plate with welded joints and necessary stiffeners on exterior of tank. Provide a braced structural steel framework support. Weld tank top tight and provide an access opening with dustproof, removable 24 inch cover. Provide 4 1/2 inch square inspection port. Provide proper venting of both inner and outer containment.

b. Float Switches: Provide tank-top mounted or external float cage, single-pole, single-throw type designed for use on fuel oil tanks. Arrange high level float switches to close on rise of liquid level, and low level float switches to close on fall of liquid level. Mount float cage units with isolating and drain valves. Contacts shall be suitable for the station battery voltage.

1. Critical low level float switch which shall activate at 5 percent of normal liquid level shall shut engine off.

2. Low-low level float switch which shall activate alarm at 30 percent of normal liquid level.

3. Low level float switch which shall open the fuel oil solenoid valve and start the fuel transfer pump at 75 percent of normal liquid level.

4. High level float switch which shall close the fuel oil solenoid valve and stop the fuel transfer pump at 90 percent of normal liquid level.

5. Critical high level float switch which shall activate alarm at 95 percent of normal liquid level.

c. Leak Detector Switch: Actuates when fuel is detected in containment basin, stops fuel transfer pump, and closes the fuel oil solenoid valve.

d. Control Panel: Provide NEMA ICS 6, Type 3R, enclosed control panel for each day tank. Control panel shall include the following accessories.

1. Power available LED (green).

2. Critical low fuel alarm contacts for shut down of engine.

3. Low-low level fuel alarm LED.

4. Low-low level fuel alarm contacts for remote annunciator.

5. Critical high level fuel alarm LED.

6. Leak detecting alarm LED.

7. Alarm horn.

e. Tank Gages: Provide buoyant force type gages for diesel fuel day tanks with dial indicator not less than 4 inches in size and arranged for top mounting. Calibrate each reading dial or scale for its specific tank to read from empty to full, with intermediate points of 1/4, 1/2, and 3/4.

f. Fuel: Provide diesel fuel for the required testing and training. Provide a full tank of fuel at the completion of all testing and training.

2.2.4.3 Fuel Oil Solenoid Valve

UL 429. Provide electric solenoid type control valve for each day tank. Solenoid shall be rated for starting battery voltage. Valve body shall have a minimum working pressure rating of 150psig at 200 degrees F. Valve shall be capable of passing 0 to 10 gpm of fuel oil. Valves shall be two-way, direct acting, normally closed (open when energized, closed when de-energized), with brass body and resilient seat material. Solenoid enclosures shall be NEMA ICS 6, Type 1. Body connections shall be same size as connecting piping. Valve shall be in line before the fuel pump.

2.2.4.4 Fuel Oil Cooler

Provide an air cooled fuel oil cooler if the temperature of the fuel returned to the tank from the engine will cause overheating of the tank fuel above the maximum fuel temperature allowed by the engine manufacturer when operating at maximum rated generator power output and low fuel level in the tank. The fuel oil cooler shall be furnished by the engine manufacturer for the application and the installation shall be complete including piping and power requirements.

2.2.5 Starting Battery System

Provide a 24-volt dc starting battery installation for starting of each engine-generator set utilizing an electric cranking system for engine generator sets greater than 100 kW and a 12-volt dc system for generators less than 100 kW..

2.2.5.1 Engine Starting Battery

Provide maintenance free, sealed, lead-acid, SAE Type D diesel engine starting batteries. Batteries shall have sufficient capacity to provide 60 seconds of continuous cranking of the engine in an ambient temperature of 0 degrees F.

2.2.5.2 Starting Battery Charger

UL 1236. Provide 120 volt ac, enclosed, automatic equalizing, dual-rate, solid-state, constant voltage type battery charger with automatic ac line compensation. Dc output shall be voltage regulated and current limited. Charger shall have two ranges, float and equalize, and shall provide continuous taper charging. The charger shall have a continuous output rating of not less than 10 amperes and shall be sized to recharge the engine starting batteries in a minimum of 8 hours while providing the control power needs of the engine-generator set. Enclosure shall be NEMA ICS 6, Type 3R. The following accessories shall be included:

a. Dc ammeter

b. Dc voltmeter

c. Equalize light

d. Ac on light

e. Low voltage light

f. High voltage light

g. Equalize test button/switch

h. Ac circuit breaker

i. Low dc voltage alarm relay

j. High dc voltage alarm relay

k. Current failure relay

l. Ac power failure relay

2.2.6 Engine-Generator Control Panel

Provide NEMA ICS 6, Type 3R, enclosed control panel mounted on the engine-generator set with vibration isolators. Provide the following control panel mounted devices and control features.

2.2.6.1 Control Panel Mounted Devices

a. Engine Control Switch (ECS): Provide a three position control switch with "MANUAL START" - "OFF/RESET" - "AUTO START" positions.

b. Emergency Stop Push Button (ESPB): Provide a red, mushroom head, twist-to-reset, maintained contact type push button.

c. Generator Metering: Provide ac metering package that displays ac voltage, current, and frequency of one phase of the generator output simultaneously. Metering package shall include a voltmeter/ammeter phase selector switch to allow viewing of each phase.

d. Generator Voltage Adjust Potentiometer (VAP): Provide a potentiometer, locking screwdriver type, to adjust generator voltage.

e. Engine Instrumentation: Provide instrumentation package that displays the following engine information:

1. Engine oil pressure
2. Engine coolant temperature
3. Engine speed (rpm)
4. Engine running hours

f. Indicating Lamps: Provide LED type indicating lamps and a lamp test switch. Lamps shall indicate the following alarm and shutdown conditions:

1. Low engine lubricating oil pressure alarm
2. Low engine lubricating oil pressure shutdown
3. High engine coolant temperature alarm
4. High engine coolant temperature shutdown
5. Engine overcrank shutdown
6. Engine overspeed shutdown
7. Emergency stop shutdown
8. Starting battery system trouble alarm
9. Day tank low fuel shutdown
10. Low engine coolant temperature alarm

11. Low coolant level shutdown

g. Alarm Horn: Provide an alarm horn and a horn silence switch.

h. Panel Lamp: Provide a panel lamp and lamp "ON-OFF" switch.

2.2.6.2 Crank Cycle/Terminate Relay

Provide crank cycle/terminate relay with adjustable crank/rest periods of 1 to 60 seconds (initially set for 15 seconds) and adjustable total crank time of 30 seconds to 10 minutes (initially set for 75 seconds).

2.2.6.3 Engine Cooldown Relay

Provide cooldown relay with adjustable cool down time of 0 to 30 minutes (initially set at engine manufacturer's recommended time).

2.2.7 Remote Alarm Annunciator

Provide NEMA ICS 6, Type 1, enclosed remote alarm annunciator. The annunciator shall have a lamp test switch and LED type indicating lamps. The annunciator shall give visual and audible warnings for the following operating and alarm conditions:

a. Provide lamps for the following operating conditions:

1. Operating power source, normal or emergency

2. Starting battery system trouble

b. Provide lamps and an audible signal for the following alarm conditions:

1. Low engine lubricating oil pressure

2. Low engine coolant temperature

3. High engine coolant temperature

4. Low fuel

5. Engine overcrank shutdown

6. Engine overspeed shutdown

2.2.8 Generator Circuit Breaker

UL 489, molded case, adjustable thermal magnetic trip type circuit breaker. The circuit breaker continuous current rating shall be adequate for the power rating of the engine-generator set and the circuit breaker shall be rated to withstand the short circuit current provided by the generator set. Provide circuit breaker in a NEMA ICS 6, Type 3R enclosure mounted on the engine-generator set.

### 2.2.9 Electrical Support Equipment

Furnish with respective pieces of equipment. Motors, controllers, contactors, and disconnects shall conform to Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide electrical connections under Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide controllers and contactors with maximum of 120-volt control circuits, and auxiliary contacts for use with controls furnished. When motors and equipment furnished are larger than size indicated, the cost of providing additional electrical service and related work shall be included under this section.

### 2.2.10 Weatherproof Enclosure

Provide for each engine-generator set and fabricate from zinc coated or phosphatized and shop primed 16 gage minimum sheet steel in accordance with the manufacturer's standard design. Provide a complete, weatherproof enclosure for the engine, generator, and auxiliary systems and equipment. Support exhaust piping and silencer so that the turbocharger is not subjected to exhaust system weight or lateral forces generated in connecting piping that exceed the engine manufacturer's maximum allowed forces and moments. The housing shall have sufficient louvered openings to allow entrance of outside air for engine and generator cooling at full load. Design louvered openings to exclude driving rain and snow. Provide properly arranged and sized, hinged panels in the enclosure to allow convenient access to the engine, generator, and control equipment for maintenance and operational procedures. Provide hinged panels with spring type latches which shall hold the panels closed securely and will not allow them to vibrate. Brace the housing internally to prevent excessive vibration when the set is in operation.

## 2.3 SPECIAL WRENCHES AND TOOLS

Wrenches and tools specifically designed and required to work on the new equipment, which are not commercially available as standard mechanic's tools, shall be furnished to the Contracting Officer’s Representative.

## 2.4 IDENTIFICATION OF EQUIPMENT

Provide plates and tags sized so that inscription is readily legible to operating or maintenance personnel and securely mounted to or attached in proximity of their identified controls or equipment. Lettering shall be normal block lettering, a minimum of 0.25 inch high.

### 2.4.1 Materials

Construct ID plates and tags of 16 gage minimum thickness bronze or stainless steel sheet metal engraved or stamped with inscription. Construct plates and tags not exposed to the weather or high operational temperature of the diesel engine of laminated plastic, 0.125 inch thick, matte white finish with black center core, with lettering accurately aligned and engraved into the core.

2.4.2 Control Devices and Operation Indicators

Provide ID plates or tags for control devices and operation indicators, including valves, off-on switches, visual alarm annunciators, gages and thermometers, that are required for operation and maintenance of provided mechanical systems. Plates or tags shall be minimum of 0.5 inch high and 2 inches long and shall indicate component system and component function.

2.4.3 Equipment

Provide ID plates of a minimum size of 3 inches high and 5 inches long on provided equipment indicating the following information:

a. Manufacturer's name, address, type and model number, and serial number;

b. Contract number and accepted date;

c. Capacity or size;

d. System in which installed; and

e. System which it controls.

2.5 ASSEMBLED OPERATION AND MAINTENANCE MANUALS

The contents of the assembled operation and maintenance manuals shall include the manufacturer's O&M information required by the paragraph entitled "SD-10, Operation and Maintenance Data" and the manufacturer's O&M information specified in Section 26 36 23 AUTOMATIC TRANSFER SWITCHES.

a. Manuals shall be in separate books or volumes, assembled and bound securely in durable, hard covered, water resistant binder, and indexed by major assembly and components in sequential order.

b. A table of contents (index) shall be made part of the assembled O&M. The manual shall be assembled in the order noted in table of contents.

c. The cover sheet or binder on each volume of the manuals shall be identified and marked with the words, "Operation and Maintenance Manual."

2.6 SOURCE QUALITY CONTROL

Perform and report on factory tests and inspections prior to shipment. Provide certified copies of manufacturer's test data and results. Test procedures shall conform to ASME, IEEE, and ANSI standards, and to ISO requirements on testing, as appropriate and applicable. The manufacturer performing the tests shall provide equipment, labor, and consumables necessary for tests and measuring and indicating devices shall be certified to be within calibration. Tests shall indicate satisfactory operation and attainment of specified performance. If satisfactory, equipment tested will be given a tentative approval. Equipment shall not be shipped before approval of the factory test reports for the following tests.

2.6.1 Engine Tests

Perform customary commercial factory tests in accordance with ISO 3046 on each engine and associated engine protective device, including, but not limited to the following:

a. Perform dynamometer test at rated power. Record horsepower at rated speed and nominal characteristics such as lubricating oil pressure, jacket water temperature, and ambient temperature.

b. Test and record the values that the low oil pressure alarm and protective shutdown devices actuate prior to assembly on the engine.

c. Test and record values that the high jacket water temperature alarm and protective shutdown devices actuate prior to assembly on the engine.

2.6.2 Generator Tests

Tests shall be performed on the complete factory assembled generator prior to shipment. Conduct tests in accordance with IEEE 115, NEMA C50.10 and NEMA MG 1.

2.6.2.1 Routine Tests

Perform the following routine tests on the generators and their exciters:

a. Resistance of armature and field windings

b. Mechanical balance

c. Phases sequence

d. Open circuit saturation curve and phase (voltage) balance test

e. Insulation resistance of armature and field windings

f. High potential test

2.6.2.2 Design Tests

Submit the following design tests made on prototype machines that are physically and electrically identical to the generators specified.

a. Temperature rise test

b. Short circuit saturation curve and current balance test

2.6.3 Assembled Engine-Generator Set Tests

Submit the following tests made on prototype machines that are physically and electrically identical to the engine-generator set specified.

2.6.3.1 Initial Stabilization Readings

Operate the engine-generator set and allow the set to stabilize at rated kW at rated power factor, rated voltage, and rated frequency. During this period record instrument readings for output power (kW), terminal voltage, line current, power factor, frequency (rpm) generator (exciter) field voltage and current, lubricating oil pressure, jacket water temperature, and ambient temperature at minimum intervals of 15 minutes. Adjust the load, voltage, and frequency to maintain rated load at rated voltage and frequency. Adjustments to load, voltage, or frequency controls shall be recorded on the data sheet at the time of adjustment. Stabilization shall be considered to have occurred when four consecutive voltage and current recorded readings of the generator (or exciter) field either remain unchanged or have only minor variations about an equilibrium condition with no evident continued increase or decrease in value after the last adjustment to the load, voltage, or frequency has been made.

2.6.3.2 Regulator Range Test

Remove load and record instrument readings (after transients have subsided). Adjust voltage to the maximum attainable value or to a value just prior to actuation of the overvoltage protection device. Apply rated load and adjust voltage to the minimum attainable value or a value just prior to activation of the undervoltage protection device. The data sheets shall indicate the voltage regulation as a percent of rated voltage and the maximum and minimum voltages attainable. Voltage regulation shall be defined as follows:

$$\text{Percent Regulation} = \frac{(\text{No-Load Voltage}) - (\text{Rated-Load Voltage})) \times 100}{(\text{Rated-Load Voltage})}$$

2.6.3.3 Frequency Range Test

Adjust the engine-generator set frequency for the maximum attainable frequency at rated load. Record instrument readings. Adjust the engine-generator set frequency for the specified minimum attainable frequency at rated load. Record instrument readings. Reduce the load to zero and adjust the engine-generator set frequency for the maximum attainable frequency.

Record instrument readings. Adjust the engine-generator set frequency for the minimum attainable frequency. Record instrument readings. The data sheet shall show the maximum and minimum frequencies attained at rated load, and at no load.

2.6.3.4 Transient Response Test

Drop the load to no load and re-apply rated load three times to ensure that the no load and rated load voltage and frequency values are repeatable and that the frequency and voltage regulation is within the limits specified. Record generator terminal voltage and frequency using a high speed strip chart recorder. The data sheet shall show the following results:

a. Frequency

1. Stability bandwidth or deviation in percent of rated frequency.

2. Recovery time.

3. Overshoot and undershoot.

b. Voltage

1. Stability bandwidth or deviation in percent of rated voltage.

2. Recovery time.

3. Overshoot and undershoot.

PART 3 EXECUTION

3.1 INSTALLATION

Installation shall conform to the applicable requirements of IEEE C2 NFPA 30, NFPA 37, and NFPA 70.

3.2 GROUNDING

NFPA 70 and IEEE C2, except that grounding systems shall have a resistance to solid earth ground not exceeding 5 ohms.

3.2.1 Grounding Electrodes

Provide driven ground rods as specified in Section 26 20 00 ELECTRICAL DISTRIBUTION SYSTEM. Connect ground conductors to the upper end of ground rods by exothermic weld or compression connector. Provide compression connectors at equipment end of ground conductors.

3.2.2 Engine-Generator Set Grounding

Provide separate copper grounding conductors and connect them to the ground system as indicated. When work in addition to that indicated or specified is required to obtain the specified ground resistance, the provision of the contract covering "Changes" shall apply.

3.2.3 Connections

Make joints in grounding conductors by exothermic weld or compression connector. Exothermic welds and compression connectors shall be installed as specified in Section 26 20 00 ELECTRICAL DISTRIBUTION SYSTEM paragraph regarding "Grounding."

3.2.4 Grounding and Bonding Equipment

UL 467, except as indicated or specified otherwise.

3.3 START-UP ENGINEER

Provide the services of a qualified factory trained start-up engineer, regularly employed by the engine-generator set manufacturer. The start-up services shall include conducting preliminary operations and functional acceptance tests. The start-up engineer shall be present at the engine generator set installation site, full-time, while preliminary operations and functional acceptance tests are being conducted.

3.4 PREREQUISITES FOR FUNCTIONAL ACCEPTANCE TESTING

Completion of the following requirements is mandatory prior to scheduling functional acceptance tests for the engine-generator set and auxiliary equipment.

3.4.1 Performance of Acceptance Checks and Tests

The acceptance checks and tests shall be accomplished by the testing organization appropriate for the respective test.

3.4.1.1 Generator Sets

Complete as specified in the paragraph entitled "Acceptance Checks and Tests."

3.4.1.2 Automatic Transfer Switches

Complete acceptance checks and tests as specified in Section 26 36 23 AUTOMATIC TRANSFER SWITCHES.

3.4.2 Preliminary Operations

The start-up engineer shall conduct manufacturer recommended start-up procedures and tests to verify that the engine-generator set and auxiliary equipment are ready for functional acceptance tests. Give the Contracting Officer's Representative 15 days' advance notice that preliminary operations will be conducted. After preliminary operation has been successfully conducted, the start-up engineer will notify the Contracting Officer in writing stating the engine-generator set and auxiliary equipment are ready for functional acceptance tests.

3.4.3 Preliminary Assembled Operation and Maintenance Manuals

Preliminary assembled operation and maintenance manuals shall have been submitted to and approved by the Contracting Officer. Manuals shall be prepared as specified in the paragraph entitled "Assembled Operation and Maintenance Manuals."

3.4.4 Functional Acceptance Test Procedure

Test procedure shall be prepared by the start-up engineer specifically for the engine-generator set and auxiliary equipment. The test agenda shall cover the requirements specified in the paragraph entitled "Functional Acceptance Tests." The test procedure shall indicate in detail how tests are to be conducted. A statement of the tests that are to be performed without indicating how the tests are to be performed is not acceptable. Indicate what work is planned on each workday and identify the calendar dates of the planned workdays. Specify what additional technical support personnel is needed such as factory representatives for major equipment. Specify on which testing workday each technical support personnel is needed. Data recording forms to be used to document test results are to be submitted with the proposed test procedure. A list of test equipment and instruments shall also be included in the test procedure.

3.4.5 Test Equipment

Test equipment and instruments shall be on hand prior to scheduling field tests or, subject to Contracting Officer's Representative approval, evidence shall be provided to show that arrangements have been made to have the necessary equipment and instruments on site prior to field testing.

3.5 FIELD QUALITY CONTROL

Give Contracting Officer's Representative 30 days notice of dates and times scheduled for tests which require the presence of the Contracting Officer's Representative. The Contracting Officer's Representative will coordinate with the using activity and schedule a time that will eliminate or minimize interruptions and interference with the activity operations. The Contractor shall be responsible for costs associated with conducting tests outside of normal working hours and with incorporating special arrangements and procedures, including temporary power conditions. The Contractor shall provide labor, equipment, diesel fuel, test load, and consumables required for the specified tests. The test load shall be a cataloged product. Calibration of measuring devices and indicating devices shall be certified. Refer to Section 26 00 00 BASIC ELECTRICAL MATERIALS AND METHODS, for requirements for a cataloged product. Perform the following field tests.

3.5.1 Acceptance Checks and Tests

Perform in accordance with the manufacturer's recommendations, and include the following visual and mechanical inspections and electrical tests, performed in accordance with NETA ATS.

3.5.1.1 Circuit Breakers - Low Voltage Insulated Case/Molded Case

a. Visual and mechanical inspection

1. Compare nameplate data with specifications and approved shop drawings.

2. Inspect circuit breaker for correct mounting.

3. Operate circuit breaker to ensure smooth operation.

4. Inspect case for cracks or other defects.

5. Verify tightness of accessible bolted connections and cable connections by calibrated torque-wrench method. Thermographic survey is not required.

6. Inspect mechanism contacts and arc chutes in unsealed units.

b. Electrical Tests

1. Perform contact-resistance tests.

2. Perform insulation-resistance tests.

3. Adjust Breaker(s) for final settings in accordance with engine-generator set manufacturer's requirements.

3.5.1.2 Current Transformers

a. Visual and Mechanical Inspection

1. Compare equipment nameplate data with specifications and approved shop drawings.

2. Inspect physical and mechanical condition.

3. Verify correct connection.

4. Verify that adequate clearances exist between primary and secondary circuit.

5. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method. Thermographic survey is not required.

6. Verify that all required grounding and shorting connections provide good contact.

b. Electrical Tests

1. Perform insulation-resistance tests.

2. Perform polarity tests.

3. Perform ratio-verification tests.

3.5.1.3 Metering and Instrumentation

a. Visual and Mechanical Inspection

1. Compare equipment nameplate data with specifications and approved shop drawings.

2. Inspect physical and mechanical condition.

3. Verify tightness of electrical connections.

b. Electrical Tests

1. Determine accuracy of meters at 25, 50, 75, and 100 percent of full scale.

2. Calibrate watthour meters according to manufacturer's published data.

3. Verify all instrument multipliers.

4. Electrically confirm that current transformer secondary circuits are intact.

3.5.1.4 Battery Systems

a. Visual and mechanical inspection

1. Compare equipment nameplate data with specifications and approved shop drawings.

2. Inspect physical and mechanical condition.

3. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method. Thermographic survey is not required.

4. Measure electrolyte specific gravity and temperature and visually check fill level.

5. Verify adequacy of battery support racks, mounting, anchorage, and clearances.

b. Electrical tests

1. Set charger float and equalizing voltage levels.

2. Verify all charger functions and alarms.

3. Measure each cell voltage and total battery voltage with charger energized and in float mode of operation.

4. Perform a capacity load test.

3.5.1.5 Engine-Generator Set

a. Visual and mechanical inspection

1. Compare equipment nameplate data with specifications and approved shop drawings.

2. Inspect physical and mechanical condition.

3. Inspect for correct anchorage and grounding.

b. Electrical and mechanical tests

1. Perform an insulation-resistance test on generator winding with respect to ground. Calculate polarization index.

2. Perform phase rotation test to determine compatibility with load requirements.

3.5.1.6 Grounding System

a. Visual and mechanical inspection

1. Inspect ground system for compliance with contract plans and specifications.

b. Electrical tests

1. Perform ground-impedance measurements utilizing the fall-of-potential method. On systems consisting of interconnected ground rods, perform tests after interconnections are complete. On systems consisting of a single ground rod perform tests before any wire is connected. Take measurements in normally dry weather, not less than 48 hours after rainfall. Use a portable ground testing megger in accordance with manufacturer's instructions to test each ground or group of grounds. The instrument shall be equipped with a meter reading directly in ohms or fractions thereof to indicate the ground value of the ground rod or grounding systems under test.

3.5.2 Functional Acceptance Tests

The tests shall be performed by the start-up engineer. Upon successful test completion, the start-up engineer shall provide the Contracting Officer with a written test report within 15 calendar days showing the tests performed and the results of each test. The report shall include the completed approved test data forms and certification from the start-up engineer that the test results fall within the manufacturer's recommended limits and meet the specified requirements performance. The report shall be dated and signed by the start-up engineer, and submitted for approval by the Contracting Officer. The Contracting Officer's Representative will witness final acceptance tests. Testing shall include but not be limited to:

a. Verify proper functioning of each engine protective shutdown device and pre-shutdown alarm device. Testing of the devices shall be accomplished by simulating device actuation and observing proper alarm and engine shutdown operation.

b. Verify proper functioning of the engine overspeed trip device. Testing of the overspeed trip device shall be accomplished by raising the speed of the engine-generator set until an overspeed trip is experienced.

c. Verify proper functioning of the crank cycle/terminate relay. Testing of the relay shall be accomplished by engaging the starter motor with the engine being prevented from running. Observe the complete crank/rest cycle as described in the paragraph entitled "Crank Cycle/Terminate Relay."

d. Verify proper functioning of the following automatic and manual operations. Testing shall include but not be limited to:

    1. Loss of Utility: Initiate a normal power failure with connected test load of rated kW at 1.0 power factor. Record time delay on start, cranking time until engine starts and runs, time to come up to operating speed, voltage and frequency overshoot, and time to achieve steady state conditions with all switches transferred to emergency position.

    2. Return of Utility: Return normal power and record time delay on retransfer for each automatic transfer switch, and time delay on engine cooldown and shutdown.

    3. Manual starting

    4. Emergency stop

e. Operate the engine-generator set at rated current (amperes) until the jacket water temperature stabilizes. Stabilization will be considered to have occurred when three consecutive temperature readings remain unchanged. Continue to operate the generator set for an additional 2 hours. Record instrument readings for terminal voltage, line current, frequency (Hz), engine speed rpm, lubricating oil pressure, jacket water temperature, and ambient temperature at 5 minute intervals for first 15 minutes and at 15 minute intervals thereafter.

## 3.6 DEMONSTRATION

Upon completion of the work and at a time approved by the Contracting Officer's Representative, the Contractor shall provide instructions by a qualified instructor to the Government personnel in the proper operation and maintenance of the equipment. Government personnel shall receive training comparable to the equipment manufacturer's factory training. The duration of instruction shall be for not less than one 8 hour working day for instruction of operating personnel and not less than one 8 hour working day for instruction of maintenance personnel.

### 3.6.1 Instructor's Qualification Resume

Instructors shall be regular employees of the engine-generator set manufacturer. The instruction personnel provided to satisfy the requirements above shall be factory certified by the related equipment manufacturer to provide instruction services. Submit the name and qualification resume of instructor to the Contracting Officer for approval.

### 3.6.2 Training Plan

Submit training plan 30 calendar days prior to training sessions. Training plan shall include scheduling, content, outline, and training material (handouts). Content shall include but not limited to the following:

#### 3.6.2.1 Operating Personnel Training

This instruction includes operating the engine-generator set, auxiliary equipment including automatic transfer switches in all modes, and the use of all functions and features specified.

#### 3.6.2.2 Maintenance Personnel Training

Shall include mechanical, hydraulic, electrical, and electronic instructions for the engine-generator set and auxiliary equipment including automatic transfer switches.

a. Mechanical Training: Shall include at least the following:

1. A review of mechanical diagrams and drawings.

2. Component location and functions.

3. Troubleshooting procedures and techniques.

4. Repair procedures.

5. Assembly/disassembly procedures.

6. Adjustments (how, when, and where).

7. Preventive maintenance procedures.

8. Review of flow diagram.

9. Valve locations and function.

10. Valve and hydraulic equipment adjustment and maintenance procedures.

11. Hydraulic system maintenance and servicing.

12. Lubrication points, type, and recommended procedures and frequency.

b. Electrical and Electronic Maintenance Training: Shall include at least the following:

1. A review of electrical and electronic systems including wiring diagrams and drawings.

2. Troubleshooting procedures for the machine and control systems.

3. Electrical and electronic equipment servicing and care.

4. Use of diagnostics to locate the causes of malfunction.

5. Procedures for adjustments (locating components, adjustments to be made, values to be measured, and equipment required for making adjustments).

6. Maintenance and troubleshooting procedures for microprocessor or minicomputer where applicable.

7. Circuit board repair procedures where applicable (with schematics provided).

8. Use of diagnostic tapes.

9. Recommended maintenance servicing and repair for motors, switches, relays, solenoids, and other auxiliary equipment and devices.

-- End of Section 26 32 13 --

SECTION 26 36 23
AUTOMATIC TRANSFER SWITCHES

PART 1 GENERAL

1.1 REFERENCES

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

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

| | |
|---|---|
| NETA ATS | (2013) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 70 | (2014; AMD 1 2013; Errata 1 2013; AMD 2 2013; Errata 2 2013; AMD 3 2014; Errata 3 2014) National Electrical Code |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 1008 | (2012; Reprint Apr 2013) Transfer Switch Equipment |
| UL 508 | (1999; Reprint Oct 2013) Industrial Control Equipment |

1.2 RELATED REQUIREMENTS

Section 26 00 00 BASIC ELECTRICAL MATERIALS AND METHODS, and Section 26 08 00 APPARATUS INSPECTION AND TESTING, apply to this section, with the additions and modifications specified herein.

1.3 SUBMITTALS

Contracting Officer's written approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Automatic Transfer Switch Drawings

SD-03 Product Data

Automatic Transfer Switches

SD-06 Test Reports

Acceptance Checks and Tests

Functional Acceptance Tests

SD-07 Certificates

Proof of Listing

SD-10 Operation and Maintenance Data

Automatic Transfer Switches

Submit in accordance with Section 01 78 23 OPERATING INSTRUCTIONS AND TRAINING.

## 1.4 QUALITY ASSURANCE

### 1.4.1 Proof of Listing

Submit proof of listing by UL 1008.

### 1.4.2 Automatic Transfer Switch Drawings

Drawings shall include outline, arrangement, and detail drawings. Detail drawings shall include manufacturer's name and catalog number, electrical ratings, total system transfer statement, reduced normal supply voltage at which transfer to the alternate supply is initiated, transfer delay times, short-circuit current rating, wiring diagram, description of interconnections, testing instructions, acceptable conductor type for terminals, tightening torque for each wire connector, and other required UL 1008 markings.

# PART 2 PRODUCTS

## 2.1 AUTOMATIC TRANSFER SWITCHES

Provide four-pole, automatic transfer switches for use in emergency systems in accordance with UL 1008. Each automatic transfer switch shall be rated for total system transfer and have the current and voltage ratings as indicated. The rating of the switch shall be adequate for withstanding the effects of the indicated RMS symmetrical fault current when protected by the indicated overcurrent device without contact welding. The switch operating mechanism shall be electrically operated from the source to which it is transferring, shall have quick-make, quick-break, load break contacts, and shall be mechanically held in both positions. Switches utilizing circuit breakers are not acceptable. Non-fire pump service transfer switches shall have manual operating means provided for maintenance and servicing accessible only by opening the enclosure. The manual operating means shall affect the opening and closing of the switch

contacts at the same rate of speed as that caused by the automatic operation of the switch. The switch enclosure shall comply with UL 508, NEMA Type 1 and shall be equipped with an equipment ground lug.

2.1.1 Automatic Transfer Switch Controls

2.1.1.1 Controls for Utility-Generator Automatic Transfer Switch

Provide all necessary controls to start the generator set upon loss of the normal (utility) source, transfer the load to the generator set upon reaching rated voltage and frequency, re-transfer the load when the normal (utility) source returns, and stop the generator set.

The switch shall include the following control features.

a. Three-phase normal source voltage sensing circuit with adjustable dropout, 75-93 percent of nominal, and pickup, 85-100 percent of nominal.

b. Engine starting control contacts with adjustable commit-to-start delay circuit, 0.5-6.0 seconds.

c. Voltage/frequency sensing circuit, set for 80 percent of nominal, for enabling load transfer to emergency source.

d. Transfer to emergency source time delay, adjustable 0-5 minutes.

e. Re-transfer to normal source time delay, adjustable 1-30 minutes.

f. Programmable exerciser to allow automatic starting of the generator set and subsequent load transfer. Exercise periods shall be selectable for 1 to 24 hours per day for 0 to 7 days a week.

g. Adjustable time delay transition or in-phase monitor feature for indicated transfer switches to allow safe transfer of highly inductive loads between two non-synchronized sources.

2.1.2 Front Panel Devices

Provide devices mounted on cabinet front inside enclosure exterior door consisting of:

a. Mode selector switch with the following positions and associated functions;

1. TEST - Simulates loss of normal/preferred source system operation.

2. NORMAL - Transfers system to normal/preferred source bypassing re-transfer time delay.

b. Lamps for indicating connected source and normal/preferred source is available.

c. Auxiliary contacts for indicating connected source and normal/preferred source available.

## PART 3 EXECUTION

### 3.1 INSTALLATION

Installation shall conform to the requirements of NFPA 70 and manufacturer's recommendation.

### 3.2 PREREQUISITES FOR FUNCTIONAL ACCEPTANCE TESTING

Completion of the following requirements is mandatory prior to scheduling functional acceptance tests for the automatic transfer switch.

#### 3.2.1 Performance of Acceptance Checks and tests

Complete as specified in paragraph entitled "Acceptance Checks and Tests". The Acceptance Checks and Tests shall be accomplished by the Testing organization as described in Section 26 08 00 APPARATUS INSPECTION AND TESTING.

#### 3.2.2 Manufacturers O&M Information

The manufacturers O&M information required by the paragraph entitled "SD-10 Operation and Maintenance Data", shall have been submitted to and approved by the Contracting Officer.

#### 3.2.3 Test Equipment

All test equipment and instruments shall be on hand prior to scheduling field tests, or subject to Contracting Officer's approval, evidence shall be provided to show that arrangements have been made to have the necessary equipment and instruments on site prior to field testing.

### 3.3 FIELD QUALITY CONTROL

Give Contracting Officer’s Representative 15 days notice of dates and times scheduled for tests which require the presence of the Contracting Officer’s Representative. The Contracting Officer’s Representative will coordinate with the using activity and schedule a time that will eliminate or minimize interruptions and interference with the activity operations. The contractor shall be responsible for costs associated with conducting tests outside of normal working hours and with incorporating special arrangements and procedures, including temporary power conditions. The contractor shall provide labor, equipment, apparatus, including test load, and consumables required for the specified tests. Calibration of all measuring devices and indicating devices shall be certified. The test load shall be a cataloged product in accordance with Section 26 00 00 BASIC ELECTRICAL MATERIALS AND METHODS. Perform the following field tests in accordance with the manufacturer's recommendations and include the following visual and mechanical inspections and electrical tests, performed in accordance with NETA ATS.

3.3.1 Automatic Transfer Switch Acceptance Checks and Tests

a. Visual and Mechanical Inspection

1. Compare equipment nameplate data with specifications and approved shop drawings.

2. Inspect physical and mechanical condition.

3. Confirm correct application of manufacturer's recommended lubricants.

4. Verify that manual transfer warnings are attached and visible.

5. Verify tightness of all control connections.

6. Verify tightness of accessible bolted connections by calibrated torque-wrench method. Thermographic survey is not required.

7. Perform manual transfer operation.

8. Verify positive mechanical interlocking between normal and alternate sources.

b. Electrical Tests

1. Measure contact-resistance.

2. Perform insulation-resistance on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole for one minute. Perform tests in both source positions.

3. Verify settings and operations of control devices.

4. Calibrate and set all relays and timers.

3.3.2 Functional Acceptance Tests

Functional Acceptance Tests shall be coordinated with Section 26 32 13 SINGLE OPERATION GENERATOR SETS and shall include simulating power failure and demonstrating the following operations for each automatic transfer switch. Contractor shall show by demonstration in service that the automatic transfer switches are in good operating condition, and function not less than five times.

a. Perform automatic transfer tests:

1. Simulate loss of normal/preferred power.

2. Return to normal/preferred power.

3. Simulate loss of emergency power.

4. Simulate all forms of single-phase conditions.

b. Verify correct operation and timing of the following functions:

1. Normal source voltage-sensing relays.

2. Engine start sequence.

3. Time delay upon transfer.

4. Alternate source voltage-sensing relays.

5. Automatic transfer operation.

6. Interlocks and limit switch function.

7. Time delay and retransfer upon normal power restoration.

-- End of Section 26 36 23 --

SECTION 26 51 00
INTERIOR LIGHTING

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A 641/A 641M | (2009a) Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire |

CALIFORNIA ENERGY COMMISSION (CEC)

| | |
|---|---|
| CEC Title 24 | (1978; R 2005) California's Energy Efficiency Standards for Residential and Nonresidential Buildings |

GREEN SEAL (GS)

| | |
|---|---|
| GC-12 | (1997) Occupancy Sensors |

ILLUMINATING ENGINEERING SOCIETY OF NORTH AMERICA (IESNA)

| | |
|---|---|
| IESNA HB-9 | (2000; Errata 2004; Errata 2005; Errata 2006) IES Lighting Handbook |

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

| | |
|---|---|
| IEEE 100 | (2000; Archived) The Authoritative Dictionary of IEEE Standards Terms |
| IEEE C2 | (2012; Errata 2012; INT 1-4 2012; INT 5-7 2013) National Electrical Safety Code |
| IEEE C62.41.1 | (2002; R 2008) Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits |
| IEEE C62.41.2 | (2002) Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| ANSI C82.11 | (Consolidated 2002) American National Standard for High-Frequency Fluorescent Lamp Ballasts--Supplements |
| ANSI/IEC C78.81 | (2005) American National Standard for Electric Lamps--Double-Capped Fluorescent Lamps--Dimensional and Electrical Characteristics |
| ANSI/IEC C78.901 | (2005) American National Standard for Electric Lamps - Single Base Fluorescent Lamps--Dimensional and Electrical Characteristics |
| ANSI/NEMA C78.LL 1256 | (2003) Procedures for Fluorescent Lamp Sample Preparation and the Toxicity Characteristic Leaching Procedure (TCLP) |
| NEMA 250 | (2008) Enclosures for Electrical Equipment (1000 Volts Maximum) |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 101 | (2012; Amendment 1 2012) Life Safety Code |
| NFPA 70 | (2014; AMD 1 2013; Errata 1 2013; AMD 2 2013; Errata 2 2013; AMD 3 2014; Errata 3 2014) National Electrical Code |

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

| | |
|---|---|
| Energy Star | (1992; R 2006) Energy Star Energy Efficiency Labeling System (FEMP) |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 1598 | (2008; Reprint Oct 2012) Luminaires |
| UL 924 | (2006; Reprint Feb 2011) Standard for Emergency Lighting and Power Equipment |
| UL 935 | (2001; R thru 2009) Standard for Fluorescent-Lamp Ballasts |

## 1.2 RELATED REQUIREMENTS

Materials not considered to be lighting equipment or lighting fixture accessories are specified in Section 26 20 00 ELECTRICAL DISTRIBUTION SYSTEM. Lighting fixtures and accessories mounted on exterior surfaces of buildings are specified in this section.

1.3 DEFINITIONS

a. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, are as defined in IEEE 100.

b. Average life is the time after which 50 percent has failed and 50 percent has survived under normal conditions.

c. Total harmonic distortion (THD) is the root mean square (RMS) of all the harmonic components divided by the total fundamental current.

1.4 SUBMITTALS

Contracting Officer's written approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

Employ the terminology, classifications, and methods prescribed by the IESNA HB-9, as applicable, for the lighting system specified in data, drawings, and reports.

SD-03 Product Data

Fluorescent lighting fixtures

Fluorescent electronic ballasts

Fluorescent lamps

Incandescent lighting fixtures

Exit signs

Emergency lighting equipment

Occupancy sensors

Local/Regional Materials

Documentation indicating distance between manufacturing facility and the project site. Indicate distance of raw material origin from the project site. Indicate relative dollar value of local/regional materials to total dollar value of products included in project.

Energy Efficiency

Submit Equipment and Performance Data for incandescent lighting fixtures in accordance with paragraph entitled, "Related Requirements," of this section.

Submit Manufacturer's catalog data for the following items:

SD-06 Test Reports

Operating test

Submit test results as stated in paragraph entitled "Field Quality Control."

Submit Test reports for Operational Tests on incandescent lighting fixtures in accordance with the paragraph entitled, "Field Testing," of this section.

SD-10 Operation and Maintenance Data

Warranty

Electronic Ballast Warranty

Lighting Control System

Submit operation and maintenance data in accordance with Section 01 78 23 OPERATING INSTRUCTIONS AND TRAINING and as specified herein, showing all light fixtures, control modules, control zones, occupancy sensors, light level sensors, power packs, dimming ballasts, schematic diagrams and all interconnecting control wire, conduit, and associated hardware.

Operational Service

Submit documentation that includes contact information, summary of procedures, and the limitations and conditions applicable to the project. Indicate manufacturer's commitment to reclaim materials for recycling and/or reuse.

## 1.5 QUALITY ASSURANCE

### 1.5.1 Fluorescent Electronic Ballasts

Submit ballast catalog data as required in the paragraph entitled "Fluorescent Lamp Electronic Ballasts" contained herein. As an option, submit the fluorescent fixture manufacturer's electronic ballast specification information in lieu of the actual ballast manufacturer's catalog data. Include published specifications and sketches, which cover the information required by the paragraph entitled "Fluorescent Lamp Electronic Ballasts" herein. This information may be supplemented by catalog data if required, containing a list of vendors with vendor part numbers.

### 1.5.2 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Provide equipment, materials, installation, and workmanship in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.5.3 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship, which have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period includes applications of equipment and materials under similar circumstances and of similar size, on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, provide products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.5.3.1 Alternative Qualifications

Products having less than a 2-year field service record are acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.5.3.2 Material and Equipment Manufacturing Date

Do not use products manufactured more than 3 years prior to date of delivery to site, unless specified otherwise.

1.5.3.3 Energy Efficiency

Comply with National Energy Policy Act and Energy Star requirements for lighting products. Submit documentation for Energy Star qualifications for equipment provided under this section. Submit data indicating lumens per watt efficiency and color rendition index of light source.

1.6 WARRANTY

Support the equipment items with service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.6.1 Electronic Ballast Warranty

Furnish the electronic ballast manufacturer's warranty, for not less than 5 years from the date of manufacture of the electronic ballast. Ballast assembly in the lighting fixture, transportation, and on-site storage is not to exceed 12 months, thereby permitting 4 years of the ballast 5 year warranty to be in service and energized. State in the warranty that the manufacturer agrees to

exchange a malfunctioning ballast and promptly ship the replacement to the using Government facility, said replacement ballast being identical to, or an improvement upon, the original design of the malfunctioning ballast.

## 1.7 OPERATIONAL SERVICE

Coordinate with manufacturer for take-back program for services which reclaim materials for recycling and/or reuse. Collect information from the manufacturer about green lease options, and submit to Contracting Officer. Placement into landfills or burning of reclaimed materials is not allowed. Indicate procedures for compliance with regulations governing disposal of mercury. When such a service is not available, seek out local recyclers to reclaim the materials.

## 1.8 SUSTAINABLE DESIGN REQUIREMENTS

### 1.8.1 Local/Regional Materials

Use materials or products extracted, harvested, or recovered, as well as manufactured, within a 500 mile radius from the project site, if available from a minimum of three sources.

# PART 2 PRODUCTS

## 2.1 PRODUCT STANDARDS

Furnish lighting fixtures completely assembled with wiring and mounting devices and ready for installation at the locations noted. Design and equip recessed fixtures in suspended ceilings for installation in the type of ceiling in which the fixture is to be installed. Design fixtures to be supported independent of the ceiling. Equip fixtures with the lamps required.

## 2.2 FLUORESCENT LIGHTING FIXTURES

Provide fluorescent fixtures, conforming to UL 1598with electronic ballasts.

### 2.2.1 Fluorescent Lamp Electronic Ballasts

Provide electronic ballasts, meeting as a minimum, the following characteristics:

a. Provide ballasts complying with UL 935, ANSI C82.11, NFPA 70, and CEC Title 24 unless specified otherwise. Provide 100 percent electronic high frequency type ballasts with no magnetic core and coil components, which provide transient immunity as recommended by IEEE C62.41.1 and IEEE C62.41.2. Design ballast for the wattage of the lamps used in the indicated application. Design ballasts to operate on the voltage system to which they are connected.

b. A power factor of 0.95 (minimum).

c. Operates at a frequency of 20,000 Hertz (minimum), and is compatible with and not cause interference with the operation of occupancy sensors or other infrared control systems. Provide ballasts operating at or above 40,000 Hertz where available.

d. Light regulation of plus or minus 10 percent lumen output with a plus or minus 10 percent input voltage regulation. Ensure ballasts have 10 percent flicker (maximum) using any compatible lamp.

e. A ballast factor between 0.85 (minimum) and 1.00 (maximum). Current crest factor - 1.7 (maximum).

f. UL listed Class P with a sound rating of "A."

g. Include circuit diagrams and lamp connections displayed on the ballast.

h. Provide programmed start ballast unless otherwise indicated.

i. Provide programmed start ballasts for compact fluorescent fixtures.

j. Provide ballasts for T-5 and smaller lamps with end-of-life protection circuits as required by ANSI/IEC C78.81 and ANSI/IEC C78.901 as applicable.

k. Provide ballasts capable of starting and maintaining operation at a minimum of 0 degrees F unless otherwise indicated.

l. Provide electronic ballasts with a full replacement warranty of 5 years from date of manufacture as specified in paragraph entitled "Electronic Ballast Warranty" herein.

2.2.1.1 T-8 Lamp Ballast

a. Total harmonic distortion (THD): 10 percent (maximum).

b. Input wattage.

1. 62 watts (maximum) when operating two F32T8 lamps

c. Ballast efficacy factor.

1. 1.44 (minimum) when operating two F32T8 lamps

d. Provide three lamp fixtures with two ballasts per fixture where multilevel switching is indicated.

2.2.1.2 T-5 Lamp Ballast

a. Total harmonic distortion (THD): 10 percent (maximum).

b. Input wattage:

1. 65 watts (maximum) when operating one F54T5HO.

2. 125 watts (maximum) when operating two F54T5HO.

3. 66 watts (maximum) when operating two F28T5.

4. 29 watts (maximum) when operating one F24T5HO.

5. 54 watts (maximum) when operating two F24T5HO.

c. Ballast efficacy factor:

1. 1.56 (minimum) when operating one F54T5HO.

2. 0.86 (minimum) when operating two F54T5HO.

3. 1.54 (minimum) when operating two F28T5.

4. 3.06 (minimum) when operating one F24T5HO.

5. 1.66 (minimum) when operating two F24T5HO.

2.2.2 Fluorescent Lamps

a. Provide T-8 rapid start low mercury lamps rated 32 watts (maximum), 2800 initial lumens (minimum), CRI of 75 (minimum), color temperature of 3500 K, with an average rated life of 20,000 hours. Provide low mercury lamps which have passed the EPA Toxicity Characteristic Leachate Procedure (TCLP) for mercury by using the lamp sample preparation procedure described in ANSI/NEMA C78.LL 1256.

b. Provide T-5HO lamps rated 54 watts (maximum, 4450 initial lumens (minimum), CRI of 85 (minimum), color temperature of 3500 K, with an average rated life of 25,000 hours.

c. Provide T-5HO lamps, 24 watts (maximum), 1750 initial lumens (minimum), CRI of 85 (minimum), color temperature of 3500 K, with an average rated life of 20,000 hours.

d. Provide T-5 lamps rated 28 watts (maximum), 2600 initial lumens (minimum), CRI of 85 (minimum, color temperature of 3500 K, with an average rated life of 20,000 hours.

e. Provide T-5 lamps rated 28 watts (maximum), 2600 initial lumens (minimum), CRI of 85 (minimum), color temperature of 3500 K, with an average rated life of 20,000 hours.

f. Provide compact fluorescent lamps: CRI 80, minimum, 3500 K, 10,000 hours average rated life, and as follows:

1. T-4, double twin tube, rated 26 watts, 1800 initial lumens (minimum), as indicated.

Average rated life is based on 3 hours operating per start.

2.2.3 Compact Fluorescent Fixtures

Provide compact fluorescent fixtures manufactured specifically for compact fluorescent lamps with ballasts integral to the fixture. Providing assemblies designed to retrofit incandescent fixtures is prohibited. Provide fixtures using lamps as indicated, with a minimum CRI of 80.

2.3 INCANDESCENT LIGHTING FIXTURES

Use of incandescent lamps and fixtures is prohibited.

2.4 RECESS- AND FLUSH-MOUNTED FIXTURES

Provide type that can be relamped from the bottom, with access to ballast from the bottom, with trim for the exposed surface of flush-mounted fixtures as indicated.

2.5 SUSPENDED FIXTURES

Provide aircraft cable attached to structure capable of supporting twice the combined weight of fixtures supported by hangers. Provide with swivel hangers to ensure a plumb installation, cadmium-plated steel with a swivel-ball tapped for the conduit size indicated. Provide hangers which allow fixtures to swing within an angle of 45 degrees. Provide rods with a minimum 0.18 inch diameter.

2.6 SUPPORT HANGERS FOR LIGHTING FIXTURES IN SUSPENDED CEILINGS

2.6.1 Wires

ASTM A 641/A 641M, galvanized regular coating, soft temper, 0.1055 inches in diameter (12 gage).

2.6.2 Rods

Threaded steel rods, 3/16 inch diameter, zinc or cadmium coated.

2.7 EQUIPMENT IDENTIFICATION

2.7.1 Manufacturer's Nameplate

Provide each item of equipment with a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

2.7.2 Labels

Provide labeled luminaires in accordance with UL 1598 requirements. Clearly mark all for operation of specific lamps and ballasts according to proper lamp type. Note the following lamp characteristics in the format "Use Only _____":

a. Lamp diameter code (T-4, T-5, T-8, T-12), tube configuration (twin, quad, triple), base type, and nominal wattage for fluorescent and compact fluorescent luminaires.

b. Lamp type, wattage, bulb type (ED17, BD56, etc.) and coating (clear or coated) for HID luminaires.

c. Start type (preheat, rapid start, instant start) for fluorescent and compact fluorescent luminaires.

d. ANSI ballast type (M98, M57, etc.) for HID luminaires.

e. Correlated color temperature (CCT) and color rendering index (CRI) for all luminaires.

Provide all markings related to lamp type clear and located to be readily visible to service personnel, but unseen from normal viewing angles when lamps are in place. Provide ballasts with clear markings indicating multi-level outputs and indicate proper terminals for the various outputs.

2.8 FACTORY APPLIED FINISH

Provide electrical equipment with factory-applied painting systems which , as a minimum, meet the requirements of NEMA 250 corrosion-resistance test.

2.9 EXIT SIGNS

UL 924, NFPA 70, and NFPA 101. Exit signs shall be self-powered type. Exit signs shall use no more than 5 watts.

2.9.1 Self-Powered LED Type Exit Signs (Battery Backup)

Provide with automatic power failure device, test switch, pilot light, and fully automatic high/low trickle charger in a self-contained power pack. Battery shall be sealed electrolyte type, shall operate unattended, and require no maintenance, including no additional water, for a period of not less than 5 years. LED exit sign shall have emergency run time of 1 1/2 hours (minimum). The light emitting diodes shall have rated lamp life of 70,000 hours (minimum).

## 2.10 EMERGENCY LIGHTING EQUIPMENT

UL 924, NFPA 70, and NFPA 101. Provide lamps in wattage indicated.

### 2.10.1 Emergency System

Each system shall consist of an automatic power failure device, test switch operable from outside of the fixture, pilot light visible from outside the fixture, and fully automatic solid-state charger in a self-contained power pack. Charger shall be either trickle, float, constant current or constant potential type, or a combination of these. Battery shall be sealed electrolyte type with capacity as required to supply power for 90 minutes at a minimum of 1400 lumens. Battery shall operate unattended and require no maintenance, including no additional water, for a period of not less than 5 years. Emergency ballasts provided with fixtures containing solid-state ballasts shall be fully compatible with the solid-state ballasts.

## 2.11 OCCUPANCY SENSORS

UL listed. Comply with GC-12. Occupancy sensors and power packs shall be designed to operate on the voltage indicated. Sensors and power packs shall have circuitry that only allows load switching at or near zero current crossing of supply voltage. Occupancy sensor mounting as indicated. Sensor shall have an LED occupant detection indicator. Sensor shall have adjustable sensitivity and adjustable delayed-off time range of 5 minutes to 15 minutes. Wall mounted sensors shall match the color of adjacent wall plates as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM, ceiling mounted sensors shall be white. Ceiling mounted sensors shall have 360 degree coverage unless otherwise indicated.

a. Ultrasonic sensor shall be crystal controlled and shall not cause detection interference between adjacent sensors.

b. Infrared sensors shall have a daylight filter. Sensor shall have a fresnel lens that is applicable to space to be controlled.

c. Ultrasonic/Infrared Combination Sensor

Occupancy detection to turn lights on requires both ultrasonic and infrared sensor detection. Lights shall remain on if either the ultrasonic or infrared sensor detects movement. Infrared sensor shall have lens selected for indicated usage and daylight filter to prevent short wavelength infrared interference. Ultrasonic sensor frequency shall be crystal controlled.

# PART 3 EXECUTION

## 3.1 INSTALLATION

Ensure all electrical installations conform to IEEE C2, NFPA 70, and to the requirements specified herein.

### 3.1.1 Lamps

Deliver lamps of the type, wattage, and voltage rating indicated to the project in the original cartons and installed just prior to project completion. Replace lamps installed and used for working light during construction prior to turnover to the Government if more than 15 percent of their rated life has been used. Test the lamps for proper operation prior to turn-over and replace if necessary with new lamps from the original manufacturer. Provide 10 percent spare lamps of each type from the original manufacturer.

### 3.1.2 Lighting Fixtures

Set lighting fixtures plumb, square, and level with ceiling and walls, in alignment with adjacent lighting fixtures, and secure in accordance with manufacturers' directions and approved drawings, in conformance with the requirements of NFPA 70. Mounting heights specified or indicated are to the bottom of fixture for ceiling-mounted fixtures and to center of fixture for wall-mounted fixtures. Obtain approval of the exact mounting for lighting fixtures on the job before commencing installation and, where applicable, after coordinating with the type, style, and pattern of the ceiling being installed. Independently support recessed and semi-recessed fixtures from the building structure by a minimum of four wires or rods per fixture and located near each corner of each fixture. Ceiling grid clips are not allowed as an alternative to independently supported light fixtures. Independently support round fixtures smaller in size than the ceiling grid from the building structure by a minimum of four wires or rods per fixture spaced approximately equidistant around the fixture. Do not support fixtures by ceiling acoustical panels. Where fixtures of sizes less than the ceiling grid are indicated to be centered in the acoustical panel, support such fixtures independently and provide at least two 3/4 inch metal channels spanning, and secured to, the ceiling tees for centering and aligning the fixture. Provide wires or rods for lighting fixture support in this section.

### 3.1.3 Suspended Fixtures

Provide suspended fixtures with 45 degree swivel hangers so that they hang plumb and locate with no obstructions within the 45 degree range in all directions. Provide the stem, canopy and fixture capable of a 45 degree swing. Support steel fixtures to prevent "oil-canning" effects. Provide fixture finishes free of scratches, nicks, dents, and warps, and matching the color and gloss specified. Provide pendants finished to match Provide stainless steel air craft cable. Provide canopies finished to match the ceiling and low profile unless otherwise shown. Ensure maximum distance between suspension points is 10 feet or as recommended by the manufacturer, whichever is less.

### 3.1.4 Ballasts

#### 3.1.4.1 Electronic Ballasts

Provide all dimming ballasts, controlled by the same controller, from the same manufacturer.

### 3.1.5 Exit Signs and Emergency Lighting Units

Wire exit signs and emergency lighting units ahead of the switch to the normal lighting circuit located in the same room or area.

### 3.1.6 Occupancy Sensor

Provide quantity of sensor units indicated as a minimum. Provide additional units to give full coverage over controlled area. Full coverage shall provide hand and arm motion detection for office and administration type areas and walking motion for industrial areas, warehouses, storage rooms and hallways. Locate the sensor(s) as indicated and in accordance with the manufacturer's recommendations to maximize energy savings and to avoid nuisance activation and deactivation due to sudden temperature or airflow changes and usage. Set sensor "on" duration to 15 minutes.

## 3.2 FIELD APPLIED PAINTING

Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Specify painting in Section 09 90 00 PAINTS AND COATINGS.

## 3.3 FIELD QUALITY CONTROL

Upon completion of installation, verify that equipment is properly installed, connected, and adjusted. Conduct an operating test to show that equipment operates in accordance with requirements of this section.

### 3.3.1 Occupancy Sensor

Test sensors for proper operation. Observe for light control over entire area being covered.

## 3.4 FIELD TESTING

Perform operational tests in accordance with referenced standards in this section.

-- End of Section 26 51 00 --

SECTION 26 56 00
EXTERIOR LIGHTING

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

| | |
|---|---|
| ASHRAE 90.1 - IP | (2013; INT 1 2013; Errata 1-2 2013) Energy Standard for Buildings Except Low-Rise Residential Buildings |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A153/A153M | (2009) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware |
| ASTM B117 | (2011) Standard Practice for Operating Salt Spray (Fog) Apparatus |

ILLUMINATING ENGINEERING SOCIETY OF NORTH AMERICA (IES)

| | |
|---|---|
| IES HB-10 | (2011) IES Lighting Handbook |
| IES LM-79 | (2008) Electrical and Photometric Measurements of Solid-State Lighting Products |
| IES LM-80 | (2008) Measuring Lumen Maintenance of LED Light Sources |
| IES RP-16 | (2010; Addendum A 2008; Addenda B & C 2009) Nomenclature and Definitions for Illuminating Engineering |
| IES RP-8 | (2000; Errata 2004; R 2005; Errata 2007) Roadway Lighting |
| IES TM-15 | (2011) Luminaire Classification System for Outdoor Luminaires |
| IES TM-21 | (2011) Projecting Long Term Lumen Maintenance of LED Light Sources |

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

| | |
|---|---|
| IEEE 100 | (2000; Archived) The Authoritative Dictionary of IEEE Standards Terms |
| IEEE C2 | (2012; Errata 2012; INT 1-4 2012; INT 5-7 2013) National Electrical Safety Code |
| IEEE C62.41.2 | (2002) Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| ANSI C136.13 | (2004; R 2009) American National Standard for Roadway Lighting Equipment, Metal Brackets for Wood Poles |
| ANSI C136.21 | (2004; R 2009) American National Standard for Roadway and Area Lighting Equipment - Vertical Tenons Used with Post-Top-Mounted Luminaires |
| ANSI C136.3 | (2005; R 2009) American National Standard for Roadway and Area Lighting Equipment Luminaire Attachments |
| NEMA 250 | (2008) Enclosures for Electrical Equipment (1000 Volts Maximum) |
| NEMA ANSLG C78.377 | (2011) American National Standard for Electric Lamps—Specifications for the Chromaticity of Solid State Lighting Products |
| NEMA C136.31 | (2010) American National for Roadway and Area Lighting Equipment - Luminaire Vibration |
| NEMA C82.77 | (2002) Harmonic Emission Limits - Related Power Quality Requirements for Lighting Equipment |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 70 | (2014; AMD 1 2013; Errata 1 2013; AMD 2 2013; Errata 2 2013; AMD 3 2014; Errata 3 2014) National Electrical Code |

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

| | |
|---|---|
| 47 CFR 15 | Radio Frequency Devices |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 1310 | (2011; Reprint Oct 2013) UL Standard for Safety Class 2 Power Units |
| UL 1598 | (2008; Reprint Oct 2012) Luminaires |
| UL 773 | (1995; Reprint Mar 2002) Standard for Plug-In, Locking Type Photocontrols for Use with Area Lighting |
| UL 773A | (2006; Reprint Nov 2013) Standard for Nonindustrial Photoelectric Switches for Lighting Control |
| UL 8750 | (2009; Reprint Sep 2013) UL Standard for Safety Light Emitting Diode (LED) Equipment for Use in Lighting Products |

## 1.2 RELATED REQUIREMENTS

Luminaires and accessories installed in interior of buildings are specified in Section 26 51 00 INTERIOR LIGHTING.

## 1.3 DEFINITIONS

a. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings shall be as defined in IEEE 100 and IES RP-16.

B. For LED luminaire light sources, "Useful Life" is the operating hours before reaching 70 percent of the initial rated lumen output (L70) with no catastrophic failures under normal operating conditions. This is also known as 70 percent "Rated Lumen Maintenance Life" as defined in IES LM-80.

## 1.4 SUBMITTALS

Contracting Officer's written approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Photometric Plan

LED Luminaire Warranty

SD-02 Shop Drawings

Luminaire drawings

SD-03 Product Data

Luminaire Light Sources

Luminaire Power Supply Units (Drivers)

Photocell

Brackets

SD-05 Design Data

Design Data for luminaires

SD-06 Test Reports

LED Luminaire - IES LM-79 Test Report

LED Light Source - IES LM-80 Test Report

Operating test

Submit operating test results as stated in paragraph entitled "Field Quality Control."

SD-07 Certificates

Luminaire Useful Life Certificate

Submit certification from the manufacturer indicating the expected useful life of the luminaires provided. The useful life shall be directly correlated from the IES LM-80 test data using procedures outlined in IES TM-21. Thermal properties of the specific luminaire and local ambient operating temperature and conditions shall be taken into consideration.

SD-10 Operation and Maintenance Data

Operational Service

Submit documentation that includes contact information, summary of procedures, and the limitations and conditions applicable to the project. Indicate manufacturer's commitment to reclaim materials for recycling and/or reuse.

## 1.5 QUALITY ASSURANCE

### 1.5.1 Drawing Requirements

#### 1.5.1.1 Luminaire Drawings

Include dimensions, effective projected area (EPA), accessories, and installation and construction details. Photometric data, including zonal lumen data, average and minimum ratio, aiming diagram, and computerized candlepower distribution data shall accompany shop drawings.

### 1.5.2 Photometric Plan

For LED luminaires, include computer-generated photometric analysis of the "designed to" values for the "end of useful life" of the luminaire installation using a light loss factor of 0.7. For LED and all other types of luminaires, the submittal shall include the following:

Horizontal illuminance measurements at finished grade, taken at a maximum of every 10 feet.

Vertical illuminance measurements at 5 feet above finished grade.

Minimum and maximum footcandle levels.

Average maintained footcandle level.

Maximum to minimum ratio for horizontal illuminance only.

### 1.5.3 Design Data for Luminaires

a. Provide distribution data according to IES classification type as defined in IES HB-10.

b. Shielding as defined by IES RP-8 or B.U.G. rating for the installed position as defined by IES TM-15.

c. Provide safety certification and file number for the luminaire family. Include listing, labeling and identification per NFPA 70 (NEC). Applicable testing bodies are determined by the US Occupational Safety Health Administration (OSHA) as Nationally Recognized Testing Laboratories (NRTL) and include: CSA (Canadian Standards Association), ETL (Edison Testing Laboratory), and UL (Underwriters Laboratories).

d. Provide long term lumen maintenance projections for each LED luminaire in accordance with IES TM-21. Data used for projections shall be obtained from testing in accordance with IES LM-80.

e. Provide wind loading calculations for luminaires mounted on poles. Weight and effective projected area (EPA) of luminaires and mounting brackets shall not exceed maximum rating of pole as installed in particular wind zone area.

1.5.4 LED Luminaire - IES LM-79 Test Report

Submit test report on manufacturer's standard production model luminaire. Submittal shall include all photometric and electrical measurements, as well as all other pertinent data outlined under "14.0 Test Report" in IES LM-79.

1.5.5 LED Light Source - IES LM-80 Test Report

Submit report on manufacturer's standard production LED package, array, or module. Submittal shall include:

a. Testing agency, report number, date, type of equipment, and LED light source being tested.

b. All data required by IES LM-80.

1.5.5.1 Test Laboratories

Test laboratories for the IES LM-79 and IES LM-80 test reports shall be one of the following:

a. National Voluntary Laboratory Accreditation Program (NVLAP) accredited for solid-state lighting testing as part of the Energy-Efficient Lighting Products laboratory accreditation program.

b. One of the qualified labs listed on the Department of Energy - Energy Efficiency & Renewable Energy, Solid-State Lighting web site.

c. A manufacturer's in-house lab that meets the following criteria:

1. Manufacturer has been regularly engaged in the design and production of high intensity discharge roadway and area luminaires and the manufacturer's lab has been successfully certifying these fixtures for a minimum of 15 years.

2. Annual equipment calibration including photometer calibration in accordance with National Institute of Standards and Technology.

1.5.6 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Equipment, materials, installation, and workmanship

shall be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

### 1.5.7 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

#### 1.5.7.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if the manufacturer has been regularly engaged in the design and production of high intensity discharge roadway and area luminaires for a minimum of 15 years. Products shall have been in satisfactory commercial or industrial use for 15 years prior to bid opening. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 15-year period.

#### 1.5.7.2 Material and Equipment Manufacturing Date

Products manufactured more than 1 year prior to date of delivery to site shall not be used, unless specified otherwise.

## 1.6 WARRANTY

The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

### 1.6.1 LED Luminaire Warranty

Provide Luminaire Useful Life Certificate.

The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

a. Provide a written five year on-site replacement warranty for material, fixture finish, and workmanship. On-site replacement includes transportation, removal, and installation of new products.

1. Finish warranty shall include warranty against failure and against substantial deterioration such as blistering, cracking, peeling, chalking, or fading.

2. Material warranty shall include:

(a) All power supply units (drivers).

(b) Replacement when more than 10 percent of LED sources in any lightbar or subassembly(s) are defective or non-starting.

b. Warranty period must begin on date of beneficial occupancy. Contractor shall provide the Contracting Officer signed warranty certificates prior to final payment.

## 1.7 OPERATIONAL SERVICE

Coordinate with manufacturer for maintenance agreement or take-back program. Collect information from the manufacturer about maintenance agreement or green lease options, and submit to Contracting Officer. Services shall reclaim materials for recycling and/or reuse. Services shall not deposit materials in landfills or burn reclaimed materials. Indicate procedures for compliance with regulations governing disposal of mercury. When such a service is not available, local recyclers shall be sought after to reclaim the materials.

# PART 2 PRODUCTS

## 2.1 PRODUCT COORDINATION

Luminaires and associated equipment and accessories for interior applications are specified in Section 26 51 00 INTERIOR LIGHTING.

## 2.2 LED LUMINAIRES

UL 1598, NEMA C82.77 and UL 8750. Provide luminaires as indicated in luminaire schedule and XL plates or details on project plans. Provide luminaires complete with light sources of quantity, type, and wattage indicated. All luminaires of the same type shall be provided by the same manufacturer.

### 2.2.1 General Requirements

a. LED luminaire housings shall be die cast or extruded aluminum.

b. LED luminaires shall be rated for operation within an ambient temperature range of minus 22 degrees F to 104 degrees F.

c. Luminaires shall be UL listed for wet locations per UL 1598.

d. Luminaires shall have IES distribution and NEMA field angle classifications as indicated in luminaire schedule on project plans per IES HB-10.

e. Housing finish shall be baked-on enamel, anodized, or baked-on powder coat paint. Finish shall be capable of surviving ASTM B117 salt fog environment testing for 2500 hours minimum without blistering or peeling.

f. Luminaires shall not exceed the following IES TM-15 Backlight, Uplight and Glare (B.U.G.) ratings:

1. Maximum Backlight (B) rating shall be determined by lighting zone in which luminaire is placed.

2. Maximum Uplight (U) rating shall be U0.

3. Maximum Glare (G) rating shall be determined by lighting zone in which luminaire is placed.

g. Luminaires shall be fully assembled and electrically tested prior to shipment from factory.

h. The finish color shall be as indicated in the luminaire schedule or detail on the project plans.

i. Luminaire lenses shall be constructed of clear tempered glass or UV-resistant acrylic.

j. Incorporate modular electrical connections, and construct luminaires to allow replacement of all or any part of the optics, heat sinks, power supply units, ballasts, surge suppressors and other electrical components using only a simple tool, such as a manual or cordless electric screwdriver.

k. Luminaires shall have a nameplate bearing the manufacturer's name, address, model number, date of manufacture, and serial number securely affixed in a conspicuous place. The nameplate of the distributing agent will not be acceptable.

l. Area luminaires shall have an integral tilt adjustment of plus or minus 5 degrees to allow the unit to be leveled in accordance with ANSI C136.3.

m. Luminaire must pass 3G vibration testing in accordance with NEMA C136.31.

n. All factory electrical connections shall be made using crimp, locking, or latching style connectors. Twist-style wire nuts are not acceptable.

2.2.2 Luminaire Light Sources

2.2.2.1 LED Light Sources

a. Correlated Color Temperature (CCT) shall be in accordance with NEMA ANSLG C78.377:

Nominal CCT: 4000 degrees K: 3985 plus or minus 275 degrees K

b. Color Rendering Index (CRI) shall be:

Greater than or equal to 70 for 4000 degrees K light sources.

c. Color Consistency:

Manufacturer shall utilize a maximum 4-step MacAdam ellipse binning tolerance for color consistency of LEDs used in luminaires.

2.2.3 Luminaire Power Supply Units (Drivers)

2.2.3.1 LED Power Supply Units (Drivers)

UL 1310. LED Power Supply Units (Drivers) shall meet the following requirements:

a. Minimum efficiency shall be 85 percent.

b. Drive current to each individual LED shall not exceed 600 mA, plus or minus 10 percent.

c. Shall be rated to operate between ambient temperatures of minus 22 degrees F and 104 degrees F.

d. Shall be designed to operate on the voltage system to which they are connected, typically ranging from 120 V to 480 V nominal.

e. Operating frequency shall be: 50 or 60 Hz.

f. Power Factor (PF) shall be greater than or equal to 0.90.

g. Total Harmonic Distortion (THD) current shall be less than or equal to 20 percent.

h. Shall meet requirements of 47 CFR 15, Class B.

i. Shall be RoHS-compliant.

j. Shall be mounted integral to luminaire. Remote mounting of power supply is not allowed.

k. Power supplies in luminaires mounted under a covered structure, such as a canopy, or where otherwise appropriate shall be UL listed with a sound rating of A.

l. Shall be equipped with over-temperature protection circuit that turns light source off until normal operating temperature is achieved.

### 2.2.4 LED Luminaire Surge Protection

Provide surge protection integral to luminaire to meet C Low waveforms as defined by IEEE C62.41.2, Scenario 1, Location Category C.

## 2.3 EXTERIOR LUMINAIRE CONTROLS

Controls shall comply with Section 9 of ASHRAE 90.1 - IP.

### 2.3.1 Photocell

UL 773 or UL 773A. Photocells shall be hermetically sealed, silicon diode light sensor type, rated at 120 volts, 50/60 Hz with single-pole, single-throw contacts. Photocell shall be designed to fail to the ON position. Housing shall be constructed of polycarbonate, rated to operate within a temperature range of minus 40 to 158 degrees F. Photocell shall turn on at 1-3 footcandles and turn off at 3 to 15 footcandles. A time delay shall prevent accidental switching from transient light sources. Provide a directional lens in front of the cell to prevent fixed light sources from creating a turnoff condition.

## 2.4 BRACKETS AND SUPPORTS

ANSI C136.3, ANSI C136.13, and ANSI C136.21, as applicable. Pole brackets shall be not less than 1 1/4 inch galvanized steel pipe secured to pole. Brackets shall be coordinated to luminaires provided, and brackets for use with one type of luminaire shall be identical. Special mountings or brackets shall be as indicated and shall be of metal which will not promote galvanic reaction with luminaire head.

## 2.5 EQUIPMENT IDENTIFICATION

### 2.5.1 Manufacturer's Nameplate

Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

### 2.5.2 Labels

Provide labeled luminaires in accordance with UL 1598 requirements. Luminaires shall be clearly marked for operation of specific light sources and ballasts according to proper light source type. The following light source characteristics shall be noted in the format "Use Only _____":

a. Correlated color temperature (CCT) and color rendering index (CRI) for all luminaires.

Markings related to lamp type shall be clear and located to be readily visible to service personnel, but unseen from normal viewing angles when lamps are in place.

## 2.6 FACTORY APPLIED FINISH

Electrical equipment shall have factory-applied painting systems which shall, as a minimum, meet the requirements of NEMA 250 corrosion-resistance test.

# PART 3 EXECUTION

## 3.1 INSTALLATION

Electrical installations shall conform to IEEE C2, NFPA 70, and to the requirements specified herein.

### 3.1.1 Photocell Switch Aiming

Aim switch according to manufacturer's recommendations.

### 3.1.2 GROUNDING

Ground noncurrent-carrying parts of equipment including luminaires, mounting arms, brackets, and metallic enclosures. Where copper grounding conductor is connected to a metal other than copper, provide specially treated or lined connectors suitable for this purpose.

## 3.2 FIELD QUALITY CONTROL

Upon completion of installation, verify that equipment is properly installed, connected, and adjusted. Conduct an operating test after 100 hours of burn-in time to show that the equipment operates in accordance with the requirements of this section.

-- End of Section 26 56 00 --

SECTION 28 31 64
FIRE DETECTION AND ALARM SYSTEM, ADDRESSABLE

PART 1 GENERAL

1.1 REFERENCES

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

ACOUSTICAL SOCIETY OF AMERICA (ASA)

| | |
|---|---|
| ASA S3.41 | (1990; R 2008) Audible Emergency Evacuation Signal (ASA 96) |

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

| | |
|---|---|
| IEEE C62.41.1 | (2002; R 2008) Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits |
| IEEE C62.41.2 | (2002) Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 70 | (2014; AMD 1 2013; Errata 1 2013; AMD 2 2013; Errata 2 2013; AMD 3 2014; Errata 3 2014) National Electrical Code |
| NFPA 72 | (2013) National Fire Alarm and Signaling Code |
| NFPA 90A | (2012) Standard for the Installation of Air Conditioning and Ventilating Systems |

UNDERWRITERS LABORATORIES (UL)

| | |
|---|---|
| UL 1242 | (2006; Reprint Jul 2012) Standard for Electrical Intermediate Metal Conduit -- Steel |
| UL 1971 | (2002; Reprint Oct 2008) Signaling Devices for the Hearing Impaired |
| UL 228 | (2006; Reprint Nov 2008) Door Closers-Holders, With or Without Integral Smoke Detectors |

| | |
|---|---|
| UL 268 | (2009) Smoke Detectors for Fire Alarm Systems |
| UL 268A | (2008; Reprint Sep 2009) Smoke Detectors for Duct Application |
| UL 38 | (2008; Reprint Dec 2008) Manual Signaling Boxes for Fire Alarm Systems |
| UL 464 | (2009; Reprint Apr 2012) Standard for Audible Signal Appliances |
| UL 521 | (1999; Reprint May 2010) Heat Detectors for Fire Protective Signaling Systems |
| UL 6 | (2007; reprint Nov 2010) Electrical Rigid Metal Conduit-Steel |
| UL 797 | (2007) Electrical Metallic Tubing -- Steel |
| UL 864 | (2003; Reprint Aug 2012) Standard for Control Units and Accessories for Fire Alarm Systems |

## 1.2 SYSTEM DESCRIPTION

A. The fire detection and alarm system and the central reporting system shall be a complete expansion of the existing system configured in accordance with NFPA 72. Furnish equipment compatible and UL listed, FM approved, or approved or listed by a nationally recognized testing laboratory in accordance with the applicable NFPA standards. Locks of any new cabinets shall be keyed the same as existing equipment cabinets. Provide four keys for the system. Furnish tags with stamped identification number for keys and locks. The new fire alarm system shall annunciate alarm and trouble conditions at the existing Notifier 640 fire alarm control panel located in the Multi-purpose Building.

### 1.2.1 Operation

Activate the system into the alarm mode by actuation of any alarm initiating device. The system will remain in the alarm mode until the initiating device is reset and the fire alarm control panel is reset and restored to normal. Alarm and supervisory initiating devices shall be individually addressable. Alarm initiating devices shall be connected to initiating device circuits (IDC), Class B, to signal line circuits (SLC), Style 4, in accordance with NFPA 72. Connect alarm notification appliances to notification appliance circuits (NAC), Class B in accordance with NFPA 72. Textual, audible, and visual appliances and systems shall comply with NFPA 72. Fire alarm system components requiring power, except for the control panel power supply, shall operate on 24 Volts dc. Addressable system shall be microcomputer (microprocessor or microcontroller) based with a minimum word size of eight bits and shall provide the following features:

a. Sufficient memory to perform as specified and as shown for addressable system.

b. Individual identity of each addressable device for the following conditions: alarm; trouble; open; short; and appliances missing/failed remote detector - sensitivity adjustment from the panel for smoke detectors.

c. Capability of each addressable device being individually disabled or enabled from the panel.

d. Size each SLC to provide 40 percent addressable expansion without hardware modifications to the panel.

1.2.2 Operational Features

The system shall have the following operating features:

a. Monitor electrical supervision of IDC, SLC, and NAC.

b. Monitor electrical supervision of the primary power (ac) supply, battery voltage, placement of alarm zone module (card, PC board) within the control panel, and transmitter tripping circuit integrity.

c. A trouble buzzer and trouble LED/LCD (light emitting diode/liquid crystal diode) to activate upon a single break, open, or ground fault condition which prevents the required normal operation of the system. The trouble signal shall also operate upon loss of primary power (ac) supply, low battery voltage, removal of alarm zone module (card, PC board), and disconnection of the circuit used for transmitting alarm signals off-premises. Submit Voltage drop calculations for notification appliance circuits to indicate that sufficient voltage is available for proper appliance operation. A trouble alarm silence switch shall be provided which will silence the trouble buzzer, but will not extinguish the trouble indicator LED/LCD. Subsequent trouble and supervisory alarms shall sound the trouble signal until silenced. After the system returns to normal operating conditions, the trouble buzzer shall again sound until the silencing switch returns to normal position, unless automatic trouble reset is provided.

d. A one person test mode. Activating an initiating device in this mode will activate an alarm for a short period of time, then automatically reset the alarm, without activating the transmitter during the entire process.

e. A transmitter disconnect switch to allow testing and maintenance of the system without activating the transmitter but providing a trouble signal when disconnected and a restoration signal when reconnected.

f. Evacuation alarm silencing switch which, when activated, will silence alarm devices, but will not affect the zone indicating LED/LCD displays on the control panel nor the operation of

the transmitter. This switch shall be over-ridden upon activation of a subsequent alarm from an unalarmed device and the NAC devices will be activated.

g. Electrical supervision for circuits used for supervisory signal services (i.e., sprinkler systems, valves, etc.). Supervision shall detect any open, short, or ground.

h. Confirmation or verification of all smoke detectors. The control panel shall interrupt the transmission of an alarm signal to the system control panel for a factory preset period. This interruption period shall be adjustable from 1 to 60 seconds and be factory set at 20 seconds. Immediately following the interruption period, a confirmation period shall be in effect during which time an alarm signal, if present, will be sent immediately to the control panel. Fire alarm devices other than smoke detectors shall be programmed without confirmation or verification.

i. The fire alarm control panel shall provide supervised addressable relays for HVAC shutdown. An override at the HVAC panel shall not be provided.

j. The fire alarm control panel shall provide the required monitoring and supervised control outputs needed to accomplish elevator recall.

k. The control panel and field panels shall be software reprogrammable to enable expansion or modification of the system without replacement of hardware or firmware. Examples of required changes are: adding or deleting devices or zones; changing system responses to particular input signals; programming certain input signals to activate auxiliary devices.

l. Zones for IDC and NAC shall be arranged as indicated on the contract drawings.

1.2.3 Alarm Functions

An alarm condition on a circuit shall automatically initiate the following functions:

a. Transmission of signals over the station telephonic fire reporting system.

b. Visual indications of the alarmed devices on the fire alarm control panel display and on the remote audible/visual display.

c. Continuous sounding or operation of alarm notification appliances throughout the building as required by ASA S3.41.

d. Deactivation of the air handling units throughout the building.

1.2.4 Primary Power

Operating power shall be provided as required by paragraph Power Supply for the System. Transfer from normal to emergency power or restoration from emergency to normal power shall be fully automatic and not cause transmission of a false alarm. Loss of ac power shall not

prevent transmission of a signal via the fire reporting system upon operation of any initiating circuit.

1.2.5 Battery Backup Power

Battery backup power shall be through use of rechargeable, sealed-type storage batteries and battery charger.

1.2.6 Interface With Existing Equipment

Interfacing components shall be furnished as required to connect the new control panel to the existing fire alarm control panel for the annunciation of alarm and trouble conditions.

1.3 SUBMITTALS

Contracting Officer's written approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail Drawings

SD-03 Product Data

Storage Batteries
Combination Audible/Visual Notification Appliances
Low Battery Voltage
Special Tools and Spare Parts
Technical Data and Computer Software
Training
Testing

SD-06 Test Reports

Testing

SD-07 Certificates

Qualifications

SD-10 Operation and Maintenance Data

Operating and Maintenance Instructions

1.4 QUALITY ASSURANCE

1.4.1 Qualifications

Submit proof of qualifications for required personnel. The installer shall submit proof of experience for the Professional Engineer, fire alarm technician, and the installing company.

1.4.1.1 Engineer and Technician

a. Registered Professional Engineer with verification of experience and at least 4 years of current experience in the design of the fire protection and detection systems.

b. National Institute for Certification in Engineering Technologies (NICET) qualifications as an engineering technician in fire alarm systems program with verification of experience and current NICET certificate.

c. The Registered Professional Engineer may perform all required items under this specification. The NICET Fire Alarm Technician shall perform only the items allowed by the specific category of certification held.

1.4.1.2 Installer

The installing Contractor shall provide the following: NICET Fire Alarm Technicians to perform the installation of the system. A NICET Level 3 Fire Alarm Technician shall supervise the installation of the fire alarm system. NICET Level 2 or higher Fire Alarm Technician shall install and terminate fire alarm devices, cabinets and panels. An electrician or NICET Level 1 Fire Alarm Technician shall install conduit for the fire alarm system. The Fire Alarm technicians installing the equipment shall be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings.

1.4.1.3 Fire Protection Engineer

Installations needing designs or modifications of fire detection, fire alarm, or fire suppression systems require the services and review of a qualified fire protection engineer. For the purposes of meeting this requirement, a qualified fire protection engineer is defined as an individual meeting one of the following conditions:

a. An engineer having a Bachelor of Science or Masters of Science Degree in Fire Protection Engineering from an accredited university engineering program, plus a minimum of 2 years' work experience in fire protection engineering.

b. A registered professional engineer (P.E.) in fire protection engineering.

c. A registered PE in a related engineering discipline and member grade status in the National Society of Fire Protection Engineers.

d. An engineer with a minimum of 10 years' experience in fire protection engineering and member grade status in the National Society of Fire Protection Engineers.

### 1.4.2 Detail Drawings

Submit detail drawings consisting of a complete list of equipment and material, including manufacturer's descriptive and technical literature, catalog cuts, and installation instructions. Note that the contract drawings show layouts based on typical audible appliances. Check the layout based on the actual audible devices to be installed and make any necessary revisions in the detail drawings. The detail drawings shall also contain complete wiring and schematic diagrams for the equipment furnished, equipment layout, and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Detail drawings and detailed point-to-point wiring diagram shall be prepared and signed by a Registered Professional Engineer or a NICET Level 4 Fire Alarm Technician showing points of connection. Diagram shall include connections between system devices, appliances, control panels, supervised devices, and equipment that is activated or controlled by the panel.

## 1.5 TECHNICAL DATA AND COMPUTER SOFTWARE

Technical data and computer software (meaning technical data which relates to computer software) which is specifically identified in this project, and which may be defined/required in other specifications, shall be delivered, strictly in accordance with the CONTRACT CLAUSES. Data delivered shall be identified by reference to the particular specification paragraph against which it is furnished. Data to be submitted shall include complete system, equipment, and software descriptions. Descriptions shall show how the equipment will operate as a system to meet the performance requirements of this contract. The data package shall also include the following:

a. Identification of programmable portions of system equipment and capabilities.

b. Description of system revision and expansion capabilities and methods of implementation detailing both equipment and software requirements.

c. Provision of operational software data on all modes of programmable portions of the fire alarm and detection system.

d. Description of Fire Alarm Control Panel equipment operation.

e. Description of auxiliary and remote equipment operations.

f. Library of application software.

g. Operation and maintenance manuals as specified in SD-19 of the Submittals paragraph.

## 1.6 DELIVERY, STORAGE, AND HANDLING

Protect equipment delivered and placed in storage from the weather, humidity and temperature variation, dirt, dust, and any other contaminants.

## 1.7 SPECIAL TOOLS AND SPARE PARTS

Submit spare parts data for each different item of material and equipment specified, not later than 3 months prior to the date of beneficial occupancy. Data shall include a complete list of parts and supplies with the current unit prices and source of supply and a list of the parts recommended by the manufacturer to be replaced after 1 year of service. Furnish software, connecting cables, proprietary equipment and two spare fuses of each type and size required, necessary for the maintenance, testing, and reprogramming of the equipment. Two percent of the total number of each different type of detector, but no less than two each, shall be furnished. Mount spare fuses in the fire alarm panel.

# PART 2 PRODUCTS

## 2.1 STANDARD PRODUCTS

Provide material and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of the products for at least 2 years prior to bid opening. Equipment shall be supported by a service organization that can provide service within 24 hours of notification.

## 2.2 NAMEPLATES

Major components of equipment shall have the manufacturer's name, address, type or style, voltage and current rating, and catalog number on a noncorrosive and nonheat-sensitive plate which is securely attached to the equipment.

## 2.3 CONTROL PANEL

Control Panel shall comply with the applicable requirements of UL 864. Panel shall be modular, installed in a surface mounted steel cabinet with hinged door and cylinder lock. Control panel shall be a clean, uncluttered, and orderly assembled panel containing components and equipment required to provide the specified operating and supervisory functions of the system. The panel shall have prominent rigid plastic, phenolic or metal identification plates for LED/LCDs, zones, SLC, controls, meters, fuses, and switches.

a. Nameplates for fuses shall also include ampere rating. The LED/LCD displays shall be located on the exterior of the cabinet door or be visible through the cabinet door. Control panel switches shall be within the locked cabinet. A suitable means (single operation) shall be provided for testing the control panel visual indicating devices (meters or LEDs/LCDs). Meters and LEDs shall be plainly visible when the cabinet door is closed. Signals and LEDs/LCDs shall be provided to indicate by zone any alarm, supervisory or trouble condition on the system.

b. Loss of power, including batteries, shall not require the manual reloading of a program. Upon restoration of power, startup shall be automatic, and shall not require any manual

operation. The loss of primary power or the sequence of applying primary or emergency power shall not affect the transmission of alarm, supervisory or trouble signals.

c. Visual annunciation shall be provided for LED/LCD visual display as an integral part of the control panel and shall identify with a word description and id number each device. Cabinets shall be provided with ample gutter space to allow proper clearance between the cabinet and live parts of the panel equipment. If more than one modular unit is required to form a control panel, the units shall be installed in a single cabinet large enough to accommodate units. Cabinets shall be painted red.

2.3.1 Remote System Audible/Visual Display

Audible appliance shall have a minimum sound level output rating of 85 dBA at 10 feet and operate in conjunction with the panel integral display. The audible device shall be silenced by a system silence switch on the remote system. The audible device shall be silenced by the system silence switch located at the remote location, but shall not extinguish the visual indication. The remote LED/LCD visual display shall provide identification, consisting of the word description and id number for each device as displayed on the control panel. A rigid plastic, phenolic or metal identification sign which reads "Fire Alarm System Remote Display" shall be provided at the remote audible/visual display. The remote visual appliance located with the audible appliance shall not be extinguished until the trouble or alarm has been cleared.

2.3.2 Circuit Connections

Connect circuit conductors entering or leaving the panel to screw-type terminals with each conductor and terminal marked for identification.

2.3.3 System Expansion and Modification Capabilities

Provide, as part of this contract, any equipment and software needed by qualified technicians to implement future changes to the fire alarm system.

2.3.4 Addressable Control Module

The control module shall be capable of operating as a relay (dry contact form C) for interfacing the control panel with other systems, and to control door holders or initiate elevator fire service. The module shall be UL listed as compatible with the control panel. The indicating device or the external load being controlled shall be configured as a Class B notification appliance circuits. The system shall be capable of supervising, audible, visual and dry contact circuits. The control module shall have both an input and output address. The supervision shall detect a short on the supervised circuit and shall prevent power from being applied to the circuit. The control model shall provide address setting means compatible with the control panel's SLC supervision and store an internal identifying code. The control module shall contain an integral LED that flashes each time the control module is polled.

### 2.3.5 Addressable Initiating Device Circuits Module

Configure the initiating device being monitored as a Class B initiating device circuits. The system shall be capable of defining any module as an alarm module and report alarm trouble, loss of polling, or as a supervisory module, and reporting supervisory short, supervisory open or loss of polling. The module shall be UL listed as compatible with the control panel. The monitor module shall provide address setting means compatible with the control panel's SLC supervision and store an internal identifying code. Monitor module shall contain an integral LED that flashes each time the monitor module is polled. Pull stations with a monitor module in a common backbox are not required to have an LED.

## 2.4 STORAGE BATTERIES

Submit substantiating battery calculations for supervisory and alarm power requirements. Ampere-hour requirements for each system component and each panel component, and the battery recharging period shall be included. Provide storage batteries which are 24 Vdc sealed, lead-calcium type requiring no additional water with ample capacity, with primary power disconnected, to operate the fire alarm system for a period of 72 hours. Following this period of battery operation, the batteries shall have ample capacity to operate all components of the system, including all alarm signaling devices in the total alarm mode for a minimum period of 15 minutes. Locate batteries at the bottom of the panel. Provide batteries with overcurrent protection in accordance with NFPA 72. Separate battery cabinets shall have a lockable, hinged cover similar to the fire alarm panel. The lock shall be keyed the same as the fire alarm control panel. Paint the cabinets to match the fire alarm control panel.

## 2.5 BATTERY CHARGER

Battery charger shall be completely automatic, 24 Vdc with high/low charging rate, capable of restoring the batteries from full discharge (18 Volts dc) to full charge within 48 hours. A pilot light indicating when batteries are manually placed on a high rate of charge shall be provided as part of the unit assembly, if a high rate switch is provided. Locate charger in control panel cabinet or in a separate battery cabinet.

## 2.6 ADDRESSABLE MANUAL FIRE ALARM STATIONS

Addressable manual fire alarm stations shall conform to the applicable requirements of UL 38. Manual stations shall be connected into signal line circuits. Stations shall be installed on flush mounted outlet boxes. Manual stations shall be mounted at 48 inches. Stations shall be single action type. Stations shall be finished in red, with raised letter operating instructions of contrasting color. Stations requiring the breaking of glass or plastic panels for operation are not acceptable. Stations employing glass rods are not acceptable. The use of a key or wrench shall be required to reset the station. Gravity or mercury switches are not acceptable. Switches and contacts shall be rated for the voltage and current upon which they operate. Addressable pull stations shall be capable of being field programmed, shall latch upon operation and remain latched until manually reset. Stations shall have a separate screw terminal for each conductor.

Surface mounted boxes shall be matched and painted the same color as the fire alarm manual stations.

## 2.7 FIRE DETECTING DEVICES

Fire detecting devices shall comply with the applicable requirements of NFPA 72, NFPA 90A, UL 268, UL 268A, and UL 521. The detectors shall be provided as indicated. Detector base shall have screw terminals for making connections. No solder connections will be allowed. Detectors located in concealed locations (above ceiling, raised floors, etc.) shall have a remote visible indicator LED/LCD. Addressable fire detecting devices, except flame detectors, shall be dynamically supervised and uniquely identified in the control panel. All fire alarm initiating devices shall be individually addressable, except where indicated. Installed devices shall conform to NFPA 70 hazard classification of the area where devices are to be installed.

### 2.7.1 Heat Detectors

Design heat detectors for detection of fire by combination fixed temperature and rate-of-rise principle. Heat detector spacing shall be rated in accordance with UL 521. Detectors located in areas subject to moisture, exterior atmospheric conditions, or hazardous locations as defined by NFPA 70, shall be types approved for such locations. Heat detectors located in attic spaces or similar concealed spaces below the roof shall be intermediate temperature rated.

#### 2.7.1.1 Combination Fixed-Temperature and Rate-of-Rise Detectors

Detectors shall be designed for semi-flush outlet box mounting and supported independently of wiring connections. Contacts shall be self-resetting after response to rate-of-rise principle. Under fixed temperature actuation, the detector shall have a permanent external indication which is readily visible. Detector units located in boiler rooms, showers, or other areas subject to abnormal temperature changes shall operate on fixed temperature principle only. The UL 521 test rating for the fixed temperature portion shall be 135 degrees F. The UL 521 test rating for the Rate-of-Rise detectors shall be rated for 50 by 50 ft.

#### 2.7.1.2 Fixed Temperature Detectors

Detectors shall be designed for semi-flush outlet box mounting and supported independently of wiring connections. Detectors shall be designed to detect high heat. The detectors shall have a specific temperature setting of 135 degrees F. The UL 521 test rating for the fixed temperature detectors shall be rated for 15 by 15 ft.

### 2.7.2 Smoke Detectors

Design smoke detectors for detection of abnormal smoke densities. Smoke detectors shall be photoelectric type. Detectors shall contain a visible indicator LED/LCD that shows when the unit is in alarm condition. Detectors shall not be adversely affected by vibration or pressure. Detectors shall be the plug-in type in which the detector base contains terminals for making wiring connections. Detectors that are to be installed in concealed (above false ceilings, etc.)

locations shall be provided with a remote indicator LED/LCD suitable for mounting in a finished, visible location.

2.7.2.1 Photoelectric Detectors

Detectors shall operate on a light scattering concept using an LED light source. Failure of the LED shall not cause an alarm condition. Detectors shall be factory set for sensitivity and shall require no field adjustments of any kind. Detectors shall have an obscuration rating in accordance with UL 268. Addressable smoke detectors shall be capable of having the sensitivity being remotely adjusted by the control panel.

2.7.2.2 Duct Detectors

Duct-mounted photoelectric smoke detectors shall be furnished and installed where indicated and in accordance with NFPA 90A. Units shall consist of a smoke detector as specified in paragraph Photoelectric Detectors, mounted in a special housing fitted with duct sampling tubes. Detector circuitry shall be mounted in a metallic enclosure exterior to the duct. Detectors shall have a manual reset. Detectors shall be rated for the air velocities of the equipment in which they are installed. Detectors shall be powered from the fire alarm panel. Sampling tubes shall run the full width of the duct. The duct detector package shall conform to the requirements of NFPA 90A, UL 268A, and shall be UL listed for use in air-handling systems. The control functions, operation, reset, and bypass shall be controlled from the fire alarm control panel. Lights to indicate the operation and alarm condition; and the test and reset buttons shall be visible and accessible with the unit installed and the cover in place. Detectors mounted above 6 feet and those mounted below 6 feet that cannot be easily accessed while standing on the floor, shall be provided with a remote detector indicator panel containing test and reset switches. Remote lamps and switches as well as the affected fan units shall be properly identified in etched plastic placards. Detectors shall have auxiliary contacts to provide control, interlock, and shutdown functions of air handler units as required by codes. The detectors shall be supplied by the fire alarm system manufacturer to ensure complete system compatibility.

2.8 NOTIFICATION APPLIANCES

Audible appliances shall conform to the applicable requirements of UL 464. Devices shall be connected into notification appliance circuits. Devices shall have a separate screw terminal for each conductor. Audible appliances shall generate a unique audible sound from other devices provided in the building and surrounding area. Surface mounted audible appliances shall be painted red. Recessed audible appliances shall be installed with a grill that is painted red with a factory finish to match the surface to which it is mounted.

2.8.1 Alarm Horns

Horns shall be surface mounted, with the matching mounting back box recessed grille and vibrating type suitable for use in an electrically supervised circuit. Horns shall produce a sound rating of at least 85 dBA at 10 feet. Horns used in exterior locations shall be specifically listed or approved for outdoor use and be provided with metal housing and protective grilles.

### 2.8.2 Visual Notification Appliances

Visual notification appliances shall conform to the applicable requirements of UL 1971 and the contract drawings. Appliances shall have clear high intensity optic lens, xenon flash tubes, and output white light. Strobe flash rate shall be between 1 to 3 flashes per second and a minimum of 75 candela nominal. Strobe shall be semi-flush mounted.

### 2.8.3 Combination Audible/Visual Notification Appliances

Combination audible/visual notification appliances shall provide the same requirements as individual units except they shall mount as a unit in standard backboxes. Units shall be factory assembled. Any other audible notification appliance employed in the fire alarm systems shall be approved by the Contracting Officer.

## 2.9 FIRE DETECTION AND ALARM SYSTEM PERIPHERAL EQUIPMENT

### 2.9.1 Conduit

Conduit and fittings shall comply with NFPA 70, UL 6, UL 1242, and UL 797.

### 2.9.2 Wiring

Wiring shall conform to NFPA 70. Wiring for 120 Vac power shall be No. 12 AWG minimum. The SLC wiring shall be fiber optic or copper cable in accordance with the manufacturers requirements. Wiring for fire alarm dc circuits shall be No. 14 AWG minimum. Voltages shall not be mixed in any junction box, housing, or device, except those containing power supplies and control relays. Wiring shall conform to NFPA 70. System field wiring shall be solid copper and installed in metallic conduit or electrical metallic tubing. Conductors shall be color coded. Conductors used for the same functions shall be similarly color coded. Wiring code color shall remain uniform throughout the circuit. Pigtail or T-tap connections to initiating device circuits, supervisory alarm circuits, and notification appliance circuits are prohibited. T-tapping using screw terminal blocks is allowed for style 5 addressable systems.

## 2.10 TRANSMITTERS

### 2.10.1 Telephonic Reporting System

The existing FACP shall be re-programmed as required to receive the alarm/trouble signals from the new FACP and for those alarm signals to be transmitted to the existing monitoring agency.

# PART 3 EXECUTION

## 3.1 EXAMINATION

After becoming familiar with details of the work, verify dimensions in the field and advise the Contracting Officer's Representative and Contracting Officer of any discrepancy before performing the work.

## 3.2 INSTALLATION

Install all work as shown, in accordance with NFPA 70 and NFPA 72, and in accordance with the manufacturer's diagrams and recommendations, unless otherwise specified. Smoke detectors shall not be installed until construction is essentially complete and the building has been thoroughly cleaned.

### 3.2.1 Power Supply for the System

Provide a single dedicated circuit connection for supplying power from a branch circuit to each building fire alarm system. The power shall be supplied as shown on the drawings. The power supply shall be equipped with a locking mechanism and marked in red with the words "FIRE ALARM CIRCUIT CONTROL".

### 3.2.2 Wiring

Conduit size for wiring shall be in accordance with NFPA 70. Wiring for the fire alarm system shall not be installed in conduits, junction boxes, or outlet boxes with conductors of lighting and power systems. Not more than two conductors shall be installed under any device screw terminal. The wires under the screw terminal shall be straight when placed under the terminal then clamped in place under the screw terminal. The wires shall be broken and not twisted around the terminal. Circuit conductors entering or leaving any mounting box, outlet box enclosure, or cabinet shall be connected to screw terminals with each terminal and conductor marked in accordance with the wiring diagram. Connections and splices shall be made using screw terminal blocks. The use of wire nut type connectors in the system is prohibited. Wiring within any control equipment shall be readily accessible without removing any component parts. The fire alarm equipment manufacturer's representative shall be present for the connection of wiring to the control panel.

### 3.2.3 Control Panel

The control panel and its assorted components shall be mounted so that no part of the enclosing cabinet is less than 12 inches nor more than 78 inches above the finished floor. Manually operable controls shall be between 36 and 42 inches above the finished floor. Panel shall be installed to comply with the requirements of UL 864.

### 3.2.4 Detectors

Detectors shall be located and installed in accordance with NFPA 72. Detectors shall be connected into signal line circuits or initiating device circuits as indicated on the drawings. Detectors shall be at least 12 inches from any part of any lighting fixture. Detectors shall be located at least 3 feet from diffusers of air handling systems. Each detector shall be provided

with appropriate mounting hardware as required by its mounting location. Detectors which mount in open space shall be mounted directly to the end of the stubbed down rigid conduit drop. Conduit drops shall be firmly secured to minimize detector sway. Where length of conduit drop from ceiling or wall surface exceeds 3 feet, sway bracing shall be provided. Detectors installed in concealed locations (above ceiling, raised floors, etc.) shall have a remote visible indicator LED/LCD in a finished, visible location.

3.2.5 Notification Appliances

Notification appliances shall be mounted 80 inches above the finished floor or 6 inches below the ceiling, whichever is lower.

3.2.6 Annunciator Equipment

Annunciator equipment shall be mounted where indicated on the drawings.

3.2.7 Addressable Initiating Device Circuits Module

The initiating device circuits module shall be used to connect supervised conventional initiating devices (water flow switches, water pressure switches, manual fire alarm stations, high/low air pressure switches, and tamper switches). The module shall mount in an electrical box adjacent to or connected to the device it is monitoring and shall be capable of Style B supervised wiring to the initiating device. In order to maintain proper supervision, there shall be no T-taps allowed on style B lines. Addressable initiating device circuits modules shall monitor only one initiating device each. Contacts in suppression systems and other fire protection subsystems shall be connected to the fire alarm system to perform supervisory and alarm functions as required by NFPA 72.

3.2.8 Addressable Control Module

Addressable and control modules shall be installed in the outlet box or adjacent to the device they are controlling. If a supplementary suppression releasing panel is provided, then the monitor modules shall he mounted in a common enclosure adjacent to the suppression releasing panel and both this enclosure and the suppression releasing panel shall be in the same room as the releasing devices. All interconnecting wires shall be supervised unless an open circuit or short circuit abnormal condition does not affect the required operation of the fire alarm system. If control modules are used as interfaces to other systems, such as HVAC or elevator control, they shall be within the control panel or immediately adjacent to it. Control modules that control a group of notification appliances shall be adjacent to the first notification appliance in the notification appliance circuits. Control modules that connect to devices shall supervise the notification appliance circuits. Control modules that connect to auxiliary systems or interface with other systems (non-life safety systems) and where not required by NFPA 72, shall not require the secondary circuits to be supervised. Contacts in suppression systems and other fire protection subsystems shall be connected to the fire alarm system to perform required alarm functions as required by NFPA 72.

## 3.3 OVERVOLTAGE AND SURGE PROTECTION

### 3.3.1 Power Line Surge Protection

All equipment connected to alternating current circuits shall be protected from surges in accordance with IEEE C62.41.1/IEEE C62.41.2 B3 combination waveform and NFPA 70. Fuses shall not be used for surge protection. The surge protector shall be rated for a maximum let thru voltage of 350 Volts ac (line-to-neutral) and 350 Volt ac (neutral-to-ground).

### 3.3.2 Low Voltage DC Circuits Surge Protection

All IDC, NAC, and communication cables/conductors, except fiber optics, shall have surge protection installed at each point where it exits or enters a building. Equipment shall be protected from surges in accordance with IEEE C62.41.1/IEEE C62.41.2 B3 combination waveform and NFPA 70. The surge protector shall be rated to protect the 24 Volt dc equipment. The maximum dc clamping voltages shall be 36 V (line-to-ground) and 72 Volt dc (line-to-line).

### 3.3.3 Signal Line Circuit Surge Protection

All SLC cables/conductors, except fiber optics, shall have surge protection/isolation circuits installed at each point where it exits or enters a building. The circuit shall be protected from surges in accordance with IEEE C62.41.1/IEEE C62.41.2 B3 combination waveform and NFPA 70. The surge protector/isolator shall be rated to protect the equipment.

## 3.4 GROUNDING

Grounding shall be provided by connecting to building ground system.

## 3.5 SUPERVISING STATION PROVISIONS

### 3.5.1 Revisions to Existing Facilities

Existing supervising components shall be modified as required and programming shall be updated to accommodate the additions and revisions to the system. Acceptance testing shall include procedures that would demonstrate that operation of existing equipment has not been degraded and that the revised configuration plus interfacing components operates compatibly with the new fire alarm system at the protected premises. Work on existing equipment shall be performed in accordance with the manufacturer's instructions or under supervision of the manufacturer's representative.

## 3.6 TRAINING

Submit lesson plans, operating instructions, maintenance procedures, and training data, furnished in manual format, for the training courses. The operations training shall familiarize designated government personnel with proper operation of the fire alarm system. Conduct the course in the

building where the system is installed or as designated by the Contracting Officer's Representative.

a. The instructions shall cover items contained in the operating and maintenance instructions. In addition, training shall be provided on performance of expansions or modifications to the fire detection and alarm system. The training period for system expansions and modifications shall consist of at least 1 training days (8 hours per day) and shall start after the system is functionally completed but prior to final acceptance tests.

b. The maintenance training course shall provide the designated government personnel adequate knowledge required to diagnose, repair, maintain, and expand functions inherent to the system. Provide training course for the maintenance staff. The training period for systems maintenance shall consist of 2 training days (8 hours per day) and shall start after the system is functionally completed but prior to final acceptance tests. Six copies of maintenance manual listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guide. The manuals shall include conduit layout, equipment layout and simplified wiring, and control diagrams of the system as installed. The manuals shall include complete procedures for system revision and expansion, detailing both equipment and software requirements. Original and backup copies of all software delivered for this project shall be provided, on each type of media utilized. Manuals shall be approved prior to training.

c. The training period for systems operation shall consist of 1 training days (8 hours per day) and shall start after the system is functionally completed but prior to final acceptance tests. Six copies of operating manual outlining step-by-step procedures required for system startup, operation, and shutdown. The manual shall include the manufacturer's name, model number, service manual, parts list, and complete description of equipment and their basic operating features.

## 3.7 TESTING

Notify the Contracting Officer's Representative at least 10 days before the preliminary and acceptance tests are to be conducted. Perform the tests in accordance with the approved test procedures in the presence of the Contracting Officer's Representative. The control panel manufacturer's representative shall be present to supervise tests. Furnish instruments and personnel required for the tests.

a. Submit detailed test procedures, prepared and signed by a Registered Professional Engineer or a NICET Level 3 Fire Alarm Technician, for the fire detection and alarm system 60 days prior to performing system tests.

b. Submit test reports, in booklet form, showing field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. Each test report shall document readings, test results and indicate the final position of controls. Include the NFPA 72 Certificate of Completion and NFPA 72 Inspection and Testing Form, with the appropriate test reports.

3.7.1 Preliminary Tests

Upon completion of the installation, subject the system to functional and operational performance tests including tests of each installed initiating and notification appliance, when required. Tests shall include the meggering of system conductors to determine that the system is free from grounded, shorted, or open circuits. Conduct the megger test prior to the installation of fire alarm equipment. If deficiencies are found, corrections shall be made and the system shall be retested to assure that it is functional. After completing the preliminary testing complete and submit the NFPA 72, Certificate of Completion and Testing Form.

3.7.2 Acceptance Test

Acceptance testing shall not be performed until the Contractor has completed and submitted the Certificate of Completion. Conduct testing in accordance with NFPA 72. The recommended tests in NFPA 72 are considered mandatory and shall verify that previous deficiencies have been corrected. The Fire alarm Technician supervising the installation of the fire alarm system shall attend the testing of the system. The test shall include all requirements of NFPA 72 and the following:

a. Test of each function of the control panel.

b. Test of each circuit in both trouble and normal modes.

c. Tests of each alarm initiating devices in both normal and trouble conditions.

d. Tests of each control circuit and device.

e. Tests of each alarm notification appliance.

f. Tests of the battery charger and batteries.

g. Complete operational tests under emergency power supply.

h. Visual inspection of wiring connections.

i. Opening the circuit at each alarm initiating device and notification appliance to test the wiring supervisory feature.

j. Ground fault.

k. Short circuit faults.

l. Stray voltage.

m. Loop resistance.

-- End of Section 28 31 64 --

SECTION 31 23 00
EXCAVATION AND FILL

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN WATER WORKS ASSOCIATION (AWWA)

| | |
|---|---|
| AWWA C600 | (2010) Installation of Ductile-Iron Water Mains and Their Appurtenances |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM C136 | (2006) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates |
| ASTM C33/C33M | (2013) Standard Specification for Concrete Aggregates |
| ASTM D1140 | (2000; R 2006) Amount of Material in Soils Finer than the No. 200 (75-micrometer) Sieve |
| ASTM D1556 | (2007) Density and Unit Weight of Soil in Place by the Sand-Cone Method |
| ASTM D1557 | (2012) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3) |
| ASTM D2321 | (2011) Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications |
| ASTM D2487 | (2011) Soils for Engineering Purposes (Unified Soil Classification System) |
| ASTM D2922 | Standard Test Methods for Density of Soil and Soil-Aggregates in Place by Nuclear Methods |
| ASTM D3017 | Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods |

| | |
|---|---|
| ASTM D4318 | (2010; E 2014) Liquid Limit, Plastic Limit, and Plasticity Index of Soils |
| ASTM D698 | (2012; E 2014) Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/cu. ft. (600 kN-m/cu. m.)) |

U.S. ARMY CORPS OF ENGINEERS (USACE)

| | |
|---|---|
| EM 385-1-1 | (2008; Errata 2011) Safety and Health Requirements Manual |

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

| | |
|---|---|
| EPA 530/F-93/004 | (1993; Rev O; Updates I, II, IIA, IIB, and III) Test Methods for Evaluating Solid Waste (Vol IA, IB, IC, and II) (SW-846) |
| EPA 600/4-79/020 | (1983) Methods for Chemical Analysis of Water and Wastes |

## 1.2 DEFINITIONS

### 1.2.1 Capillary Water Barrier

A layer of clean, poorly graded crushed rock, stone, or natural sand or gravel having a high porosity which is placed beneath a building slab with or without a vapor barrier to cut off the capillary flow of pore water to the area immediately below a slab. Number 57 gradation or similar.

### 1.2.2 Degree of Compaction

Degree of compaction is expressed as a percentage of the maximum density obtained by the test procedure presented in ASTM D698, for general soil types, abbreviated as percent laboratory maximum density.

### 1.2.3 Hard Materials

Weathered rock, dense consolidated deposits, or conglomerate materials which are not included in the definition of "rock" but which usually require the use of heavy excavation equipment, ripper teeth, or jack hammers for removal.

### 1.2.4 Rock

Solid homogeneous interlocking crystalline material with firmly cemented, laminated, or foliated masses or conglomerate deposits, neither of which can be removed without systematic drilling

and blasting, drilling and the use of expansion jacks or feather wedges, or the use of backhoe-mounted pneumatic hole punchers or rock breakers; also large boulders, buried masonry, or concrete other than pavement exceeding 1/2 cubic yard in volume. Removal of hard material will not be considered rock excavation because of intermittent drilling and blasting that is performed merely to increase production.

## 1.3 SUBMITTALS

Contracting Officer's written approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-06 Test Reports

Borrow Site Testing

Fill and backfill test

Porous fill test for capillary water barrier

Density tests

Copies of all laboratory and field test reports within 24 hours of the completion of the test.

## 1.4 DELIVERY, STORAGE, AND HANDLING

Perform in a manner to prevent contamination or segregation of materials.

## 1.5 CRITERIA FOR BIDDING

Base bids on the following criteria:

a. Surface elevations are as indicated.

b. Pipes or other artificial obstructions, except those indicated, will not be encountered.

c. Ground water elevations indicated by the boring log were those existing at the time subsurface investigations were made and do not necessarily represent ground water elevation at the time of construction.

d. Material character is indicated by the boring logs.

e. Hard materials will not be encountered except as noted on the boring logs.

f. Borrow material, Suitable backfill and bedding material in the quantities required is not available at the project on Government property.

g. Blasting will not be permitted. Remove material in an approved manner.

## 1.6 REQUIREMENTS FOR OFF SITE SOIL

Soils brought in from off site for use as backfill shall be tested for TPH, BTEX and full TCLP including ignitability, corrosivity and reactivity. Backfill shall contain less than 100 parts per million (ppm) of total petroleum hydrocarbons (TPH) and less than 10 ppm of the sum of Benzene, Toluene, Ethyl Benzene, and Xylene (BTEX) and shall not fail the TCPL test. TPH concentrations shall be determined by using EPA 600/4-79/020 Method 418.1. BTEX concentrations shall be determined by using EPA 530/F-93/004 Method 5030/8020. TCLP shall be performed in accordance with EPA 530/F-93/004 Method 1311. Provide Borrow Site Testing for TPH, BTEX and TCLP from a composite sample of material from the borrow site, with at least one test from each borrow site. Material shall not be brought on site until tests have been approved by the Contracting Officer.

## 1.7 QUALITY ASSURANCE

### 1.7.1 Utilities

Movement of construction machinery and equipment over pipes and utilities during construction shall be at the Contractor's risk. Excavation made with power-driven equipment is not permitted within two feet of known Government-owned utility or subsurface construction. For work immediately adjacent to or for excavations exposing a utility or other buried obstruction, excavate by hand. Start hand excavation on each side of the indicated obstruction and continue until the obstruction is uncovered or until clearance for the new grade is assured. Support uncovered lines or other existing work affected by the contract excavation until approval for backfill is granted by the Contracting Officer's Representative. Report damage to utility lines or subsurface construction immediately to the Contracting Officer's Representative and Contracting Officer.

# PART 2 PRODUCTS

## 2.1 SOIL MATERIALS

### 2.1.1 Satisfactory Materials

As indicated on the plans.

### 2.1.2 Unsatisfactory Materials

Materials which do not comply with the requirements for satisfactory materials. Unsatisfactory materials also include man-made fills, trash, refuse, or backfills from previous construction. Unsatisfactory material also includes material classified as satisfactory which contains root and other organic matter, frozen material, and stones larger than 3 inches. The Contracting Officer's Representative shall be notified of any contaminated materials.

2.1.3 Cohesionless and Cohesive Materials

Cohesionless materials include materials classified in ASTM D 2487 as GW, GP, SW, and SP. Cohesive materials include materials classified as GC, SC, ML, CL, MH, and CH. Materials classified as GM, GP-GM, GW-GM, SW-SM, SP-SM, and SM shall be identified as cohesionless only when the fines are nonplastic (plasticity index equals zero). Materials classified as GM and SM will be identified as cohesive only when the fines have a plasticity index greater than zero.

2.1.4 Expansive Soils

Soils that have a plasticity index equal to or greater than 15 when tested in accordance with ASTM D 4318.

2.1.5 Common Fill

Approved, unclassified soil material with the characteristics required to compact to the soil density specified for the intended location.

2.1.6 Backfill and Fill Material

As indicated on the plans.

2.1.7 Select Material

As indicated on the plans.

2.1.8 Topsoil

Natural, friable soil representative of productive, well-drained soils in the area, free of subsoil, stumps, rocks larger than one inch diameter, brush, weeds, toxic substances, and other material detrimental to plant growth. Amend topsoil pH range to obtain a pH of 5.5 to 7.

2.2 POROUS FILL FOR CAPILLARY WATER BARRIER

Coarse aggregate Size 57 and conforming to the general soil material requirements specified in paragraph entitled "Satisfactory Materials."

2.3 UTILITY BEDDING MATERIAL

Except as specified otherwise in the individual piping section, provide bedding for buried piping in accordance with AWWA C600, Type 4, except as specified herein. Backfill to top of pipe shall be compacted to 95 percent of ASTM D698 maximum density. Plastic piping shall have bedding to spring line of pipe. Provide ASTM D2321 materials as follows:

a. Class I: Angular, 0.25 to 1.5 inches, graded stone, including a number of fill materials that have regional significance such as coral, slag, cinders, crushed stone, and crushed shells.

b. Class II: Coarse sands and gravels with maximum particle size of 1.5 inches, including various graded sands and gravels containing small percentages of fines, generally granular and noncohesive, either wet or dry. Soil Types GW, GP, SW, and SP are included in this class as specified in ASTM D 2487.

## 2.4 BORROW

Obtain borrow materials from sources outside of Government property.

## 2.5 BURIED WARNING AND IDENTIFICATION TAPE

Polyethylene plastic and metallic core or metallic-faced, acid- and alkali-resistant, polyethylene plastic warning tape manufactured specifically for warning and identification of buried utility lines. Provide tape on rolls, 3 inch minimum width, color coded as specified below for the intended utility with warning and identification imprinted in bold black letters continuously over the entire tape length. Warning and identification to read, "CAUTION, BURIED (intended service) LINE BELOW" or similar wording. Color and printing shall be permanent, unaffected by moisture or soil.

| Warning Tape Color Codes | |
|---|---|
| Yellow: | Electric |
| Blue: | Potable Water Systems |
| Green: | Sewer Systems |

### 2.5.1 Warning Tape for Metallic Piping

Acid and alkali-resistant polyethylene plastic tape conforming to the width, color, and printing requirements specified above. Minimum thickness of tape shall be 0.003 inch. Tape shall have a minimum strength of 1500 psi lengthwise, and 1250 psi crosswise, with a maximum 350 percent elongation.

### 2.5.2 Detectable Warning Tape for Non-Metallic Piping

Polyethylene plastic tape conforming to the width, color, and printing requirements specified above. Minimum thickness of the tape shall be 0.004 inch. Tape shall have a minimum strength of 1500 psi lengthwise and 1250 psi crosswise. Tape shall be manufactured with integral wires, foil backing, or other means of enabling detection by a metal detector when tape is buried up to 3 feet deep. Encase metallic element of the tape in a protective jacket or provide with other means of corrosion protection.

## 2.6 DETECTION WIRE FOR NON-METALLIC PIPING

Detection wire shall be insulated single strand, solid copper with a minimum of 12 AWG.

# PART 3 EXECUTION

## 3.1 PROTECTION

### 3.1.1 Shoring and Sheeting

Provide shoring bracing, cribbing, trench boxes, underpinning and sheeting as required. In addition to Section 25 A and B of EM 385-1-1 and other requirements set forth in this contract, include provisions in the shoring and sheeting plan that will accomplish the following:

a. Prevent undermining of pavements, foundations and slabs.

b. Prevent slippage or movement in banks or slopes adjacent to the excavation.

### 3.1.2 Drainage and Dewatering

Provide for the collection and disposal of surface and subsurface water encountered during construction.

#### 3.1.2.1 Drainage

So that construction operations progress successfully, completely drain construction site during periods of construction to keep soil materials sufficiently dry. The Contractor shall establish/construct storm drainage features (ponds/basins) at the earliest stages of site development, and throughout construction grade the construction area to provide positive surface water runoff away from the construction activity and/or provide temporary ditches, swales, and other drainage features and equipment as required to maintain dry soils, prevent erosion and undermining of foundations. When unsuitable working platforms for equipment operation and unsuitable soil support for subsequent construction features develop, remove unsuitable material and provide new soil material as specified herein. It is the responsibility of the Contractor to assess the soil and ground water conditions presented by the plans and specifications and to employ necessary measures to permit construction to proceed. Excavated slopes and backfill surfaces shall be protected to prevent erosion and sloughing. Excavation shall be performed so that the site, the area immediately surrounding the site, and the area affecting operations at the site shall be continually and effectively drained.

#### 3.1.2.2 Dewatering

Groundwater flowing toward or into excavations shall be controlled to prevent sloughing of excavation slopes and walls, boils, uplift and heave in the excavation and to eliminate interference with orderly progress of construction. French drains, sumps, ditches or trenches will not be permitted within 3 feet of the foundation of any structure, except with specific written

approval, and after specific contractual provisions for restoration of the foundation area have been made. Control measures shall be taken by the time the excavation reaches the water level in order to maintain the integrity of the in situ material. While the excavation is open, the water level shall be maintained continuously, at least 2 feet below the working level.

### 3.1.3 Underground Utilities

Location of the existing utilities indicated is approximate. The Contractor shall physically verify the location and elevation of the existing utilities indicated prior to starting construction. The Contractor shall contact the North Carolina 811 for assistance in locating existing utilities.

### 3.1.4 Machinery and Equipment

Movement of construction machinery and equipment over pipes during construction shall be at the Contractor's risk. Repair, or remove and provide new pipe for existing or newly installed pipe that has been displaced or damaged.

## 3.2 SURFACE PREPARATION

### 3.2.1 Clearing and Grubbing

Unless indicated otherwise, remove trees, stumps, logs, shrubs, brush and vegetation and other items that would interfere with construction operations within the clearing limits. Remove stumps entirely. Grub out matted roots and roots over 2 inches in diameter to at least 18 inches below existing surface.

### 3.2.2 Stripping

Strip a minimum of 4" of topsoil from the site where excavation or grading is indicated and stockpile separately from other excavated material. Material unsuitable for use as topsoil shall be wasted. Locate topsoil so that the material can be used readily for the finished grading. Where sufficient existing topsoil conforming to the material requirements is not available on site, provide borrow materials suitable for use as topsoil. Protect topsoil and keep in segregated piles until needed.

### 3.2.3 Unsuitable Material

Remove vegetation, debris, decayed vegetable matter, sod, mulch, and rubbish underneath paved areas or concrete slabs.

## 3.3 EXCAVATION

Excavate to contours, elevation, and dimensions indicated. Reuse excavated materials that meet the specified requirements for the material type required at the intended location. Keep excavations free from water. Excavate soil disturbed or weakened by Contractor's operations, soils softened or made unsuitable for subsequent construction due to exposure to weather.

Excavations below indicated depths will not be permitted except to remove unsatisfactory material. Unsatisfactory material encountered below the grades shown shall be removed as directed. Refill with satisfactory material and compact to 95 percent of ASTM D698 maximum density. Unless specified otherwise, refill excavations cut below indicated depth with backfill and fill material and compact to 95 percent of ASTM D698 maximum density. Satisfactory material removed below the depths indicated, without specific direction of the Contracting Officer's Representative, shall be replaced with satisfactory materials to the indicated excavation grade; except as specified for spread footings. Determination of elevations and measurements of approved overdepth excavation of unsatisfactory material below grades indicated shall be done under the direction of the Contracting Officer's Representative.

3.3.1 Structures With Spread Footings

Ensure that footing subgrades have been inspected and approved by the Contracting Officer’s Representative prior to concrete placement. Fill over excavations with concrete during foundation placement.

3.3.2 Pile Cap Excavation and Backfilling

Excavate to bottom of pile cap prior to placing or driving piles, unless authorized otherwise by the Contracting Officer’s Representative. Backfill and compact overexcavations and changes in grade due to pile driving operations to 95 percent of ASTM D698 maximum density.

3.3.3 Pipe Trenches

Excavate to the dimension indicated. Grade bottom of trenches to provide uniform support for each section of pipe after pipe bedding placement. Tamp if necessary to provide a firm pipe bed. Recesses shall be excavated to accommodate bells and joints so that pipe will be uniformly supported for the entire length. Rock, where encountered, shall be excavated to a depth of at least 6 inches below the bottom of the pipe.

3.3.4 Excavated Materials

Satisfactory excavated material required for fill or backfill shall be placed in the proper section of the permanent work required or shall be separately stockpiled if it cannot be readily placed. Satisfactory material in excess of that required for the permanent work and all unsatisfactory material shall be disposed of as specified in Paragraph "DISPOSITION OF SURPLUS MATERIAL."

3.3.5 Final Grade of Surfaces to Support Concrete

Excavation to final grade shall not be made until just before concrete is to be placed. Only excavation methods that will leave the foundation rock in a solid and unshattered condition shall be used. Approximately level surfaces shall be roughened, and sloped surfaces shall be cut as indicated into rough steps or benches to provide a satisfactory bond. Shales shall be protected

from slaking and all surfaces shall be protected from erosion resulting from ponding or flow of water.

## 3.4 SUBGRADE PREPARATION

Unsatisfactory material in surfaces to receive fill or in excavated areas shall be removed and replaced with satisfactory materials as directed by the Contracting Officer's Representative. The surface shall be scarified to a depth of 6 inches before the fill is started. Sloped surfaces steeper than 1 vertical to 4 horizontal shall be plowed, stepped, benched, or broken up so that the fill material will bond with the existing material. When subgrades are less than the specified density, the ground surface shall be broken up to a minimum depth of 6 inches, pulverized, and compacted to the specified density. When the subgrade is part fill and part excavation or natural ground, the excavated or natural ground portion shall be scarified to a depth of 12 inches and compacted as specified for the adjacent fill. Material shall not be placed on surfaces that are muddy, frozen, or contain frost. Compaction shall be accomplished by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, or other approved equipment well suited to the soil being compacted. Material shall be moistened or aerated as necessary to provide the moisture content that will readily facilitate obtaining the specified compaction with the equipment used. Minimum subgrade density shall be as specified herein.

## 3.5 FILLING AND BACKFILLING

Fill and backfill to contours, elevations, and dimensions indicated. Compact each lift before placing overlaying lift.

### 3.5.1 Common Fill Placement

Provide for general site and under porous fill of pile-supported structures. Use satisfactory materials. Place in 6 inch lifts. Compact areas not accessible to rollers or compactors with mechanical hand tampers. Aerate material excessively moistened by rain to a satisfactory moisture content. Finish to a smooth surface by blading, rolling with a smooth roller, or both.

### 3.5.2 Backfill and Fill Material Placement

Provide for paved areas and under concrete slabs, except where select material is provided. Place in 6 inch lifts. Do not place over wet or frozen areas. Place backfill material adjacent to structures as the structural elements are completed and accepted. Backfill against concrete only when approved. Place and compact material to avoid loading upon or against the structure.

### 3.5.3 Select Material Placement

Provide under structures. Place in 6 inch lifts. Do not place over wet or frozen areas. Backfill adjacent to structures shall be placed as structural elements are completed and accepted. Backfill against concrete only when approved. Place and compact material to avoid loading upon or against structure.

### 3.5.4 Backfill and Fill Material Placement Over Pipes and at Walls

Backfilling shall not begin until construction below finish grade has been approved, underground utilities systems have been inspected, tested and approved, forms removed, and the excavation cleaned of trash and debris. Backfill shall be brought to indicated finish grade. Where pipe is coated or wrapped for protection against corrosion, the backfill material up to an elevation 2 feet above sewer lines and 1 foot above other utility lines shall be free from stones larger than 1 inch in any dimension. Heavy equipment for spreading and compacting backfill shall not be operated closer to foundation or retaining walls than a distance equal to the height of backfill above the top of footing; the area remaining shall be compacted in layers not more than 4 inches in compacted thickness with power-driven hand tampers suitable for the material being compacted. Backfill shall be placed carefully around pipes or tanks to avoid damage to coatings, wrappings, or tanks. Backfill shall not be placed against foundation walls prior to 7 days after completion of the walls. As far as practicable, backfill shall be brought up evenly on each side of the wall and sloped to drain away from the wall.

## 3.6 BORROW

Where satisfactory materials are not available in sufficient quantity from required excavations, approved borrow materials shall be obtained as specified herein.

## 3.7 BURIED WARNING AND IDENTIFICATION TAPE

Provide buried utility lines with utility identification tape. Bury tape 12 inches below finished grade; under pavements and slabs, bury tape 6 inches below top of subgrade.

## 3.8 BURIED DETECTION WIRE

Bury detection wire directly above non-metallic piping at a distance not to exceed 12 inches above the top of pipe. The wire shall extend continuously and unbroken, from manhole to manhole. The ends of the wire shall terminate inside the manholes at each end of the pipe, with a minimum of 3 feet of wire, coiled, remaining accessible in each manhole. The wire shall remain insulated over it's entire length. The wire shall enter manholes between the top of the corbel and the frame, and extend up through the chimney seal between the frame and the chimney seal. For force mains, the wire shall terminate in the valve pit at the pump station end of the pipe.

## 3.9 COMPACTION

Determine in-place density of existing subgrade; if required density exists, no compaction of existing subgrade will be required.

### 3.9.1 General Site

Compact underneath areas designated for vegetation and areas outside the 5 foot line of the paved area or structure to 90 percent of ASTM D698.

3.9.2 Structures, Spread Footings, and Concrete Slabs

Compact top 12 inches of subgrades to 95 percent of ASTM D698. Compact fill and backfill material to 95 percent of ASTM D698.

3.9.3 Adjacent Area

Compact areas within 5 feet of structures to 90 percent of ASTM D698.

3.9.4 Paved Areas

Compact top 12 inches of subgrades to 95 percent of ASTM D698. Compact fill and backfill materials to 95 percent of ASTM D698.

3.10 FINISH OPERATIONS

3.10.1 Grading

Finish grades as indicated within one-tenth of one foot. Grade areas to drain water away from structures. Maintain areas free of trash and debris. For existing grades that will remain but which were disturbed by Contractor's operations, grade as directed.

3.10.2 Topsoil and Seed

Scarify existing subgrade. Provide 4 inches of topsoil for newly graded finish earth surfaces and areas disturbed by the Contractor. Topsoil shall not be placed when the subgrade is frozen, excessively wet, extremely dry, or in a condition otherwise detrimental to seeding, planting, or proper grading. If there is insufficient on-site topsoil meeting specified requirements for topsoil, provide topsoil required in excess of that available. Seed shall be provided per Section 32 92 19.

3.10.3 Protection of Surfaces

Protect newly backfilled, graded, and topsoiled areas from traffic, erosion, and settlements that may occur. Repair or reestablish damaged grades, elevations, or slopes.

3.11 DISPOSITION OF SURPLUS MATERIAL

Remove from Government property surplus or other soil material not required or suitable for filling or backfilling, and brush, refuse, stumps, roots, and timber.

3.12 FIELD QUALITY CONTROL

3.12.1 Sampling

Take the number and size of samples required to perform the following tests.

3.12.2 Testing

Perform one of each of the following tests for each material used. Provide additional tests for each source change.

3.12.2.1 Fill and Backfill Material Testing

Test fill and backfill material in accordance with ASTM C136 for conformance to ASTM D2487 gradation limits; ASTM D1140 for material finer than the No. 200 sieve; ASTM D4318 for liquid limit and for plastic limit; ASTM D698 or ASTM D1557 for moisture density relations, as applicable.

3.12.2.2 Select Material Testing

Test select material in accordance with ASTM C136 for conformance to ASTM D2487 gradation limits; ASTM D1140 for material finer than the No. 200 sieve; ASTM D698 or ASTM D1557 for moisture density relations, as applicable.

3.12.2.3 Porous Fill Testing

Test porous fill in accordance with ASTM C136 for conformance to gradation specified in ASTM C33/C33M.

3.12.2.4 Density Tests

Test density in accordance with ASTM D1556, or ASTM D2922 and ASTM D3017. When ASTM D2922 and ASTM D3017 density tests are used, verify density test results by performing an ASTM D1556 density test at a location already ASTM D2922 and ASTM D3017 tested as specified herein. Perform an ASTM D1556 density test at the start of the job, and for every 10, ASTM D2922 and ASTM D3017 density tests thereafter. Test each lift at randomly selected locations every 2000 square feet of existing grade in fills for structures and concrete slabs, and every 2500 square feet for other fill areas and every 2000 square feet of pavement subgrade in cut. Include density test results in daily report.

a. Bedding and backfill in trenches: One test per 50 linear feet in each lift.

-- End of Section 31 23 00 --

SECTION 31 31 16
SOIL TREATMENT FOR SUBTERRANEAN TERMITE CONTROL

# PART 1 GENERAL

## 1.1 SUBMITTALS

Contracting Officer's written approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Termiticides

Manufacturer's label and Material Safety Data Sheet (MSDS) for termiticides proposed for use.

Verification of Measurement

Written verification that the volume of termiticide used meets the application rate.

Warranty

Copy of Contractor's warranty.

SD-07 Certificates

Qualifications

Qualifications and state license number of the termiticide applicator.

## 1.2 QUALITY ASSURANCE

Comply with DODI 4150.07 for requirements on Contractor's licensing, certification, and record keeping. Maintain daily records using Pest Management Maintenance Record, DD Form 1532-1 or equivalent computer form and submit copies of records when requested by the Contracting Officer's Representative.

Upon completion of this work, submit Pest Management Report DD Form 1532 or equivalent computer form identifying target pest, type of operation, brand name and manufacturer of pesticide, formulation, concentration or rate of application used.

### 1.2.1 Qualifications

For the application of pesticides, use the services of a subcontractor whose principal business is pest control. The subcontractor shall be licensed and certified in the state where the work is to

be performed. Termiticide applicators shall also be certified in the U.S. Environmental Protection Agency (EPA) pesticide applicator category which includes structural pest control.

1.2.2 Safety Requirements

Formulate, treat, and dispose of termiticides and their containers in accordance with label directions. Draw water for formulating only from sites designated by the Contracting Officer's Representative, and fit the filling hose with a backflow preventer meeting local plumbing codes or standards. The filling operation shall be under the direct and continuous observation of a contractor's representative to prevent overflow. Secure pesticides and related materials under lock and key when unattended. Ensure that proper protective clothing and equipment are worn and used during all phases of termiticide application. Dispose of used pesticide containers off Government property.

1.3 DELIVERY, STORAGE, AND HANDLING

1.3.1 Delivery

Deliver termiticide material to the site in the original unopened containers bearing legible labels indicating the EPA registration number and manufacturer's registered uses. All other materials, to be used on site for the purpose of termite control, shall be delivered in new or otherwise good condition as supplied by the manufacturer or formulator.

1.3.2 Inspection

Inspect termiticides upon arrival at the job site for conformity to type and quality in accordance with paragraph TERMITICIDES. Each label shall bear evidence of registration under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), as amended or under appropriate regulations of the host county. Other materials shall be inspected for conformance with specified requirements. Remove unacceptable materials from the job site.

1.3.3 Storage

Store materials in designated areas and in accordance with manufacturer's labels. Termiticides and related materials shall be kept under lock and key when unattended.

1.3.4 Handling

Observe manufacturer's warnings and precautions. Termiticides shall be handled in accordance with manufacturer's labels, preventing contamination by dirt, water, and organic material. Protect termiticides from sunlight as recommended by the manufacturer.

1.4 SITE CONDITIONS

The following conditions will determine the time of application.

1.4.1 Soil Moisture

Soils to be treated shall be tested immediately before application. Test soil moisture content to a minimum depth of 3 inches. The soil moisture shall be as recommended by the termiticide manufacturer. The termiticide will not be applied when soil moisture exceeds manufacturer's recommendations because termiticides do not adhere to the soil particles in saturated soils.

1.4.2 Runoff and Wind Drift

Do not apply termiticide during or immediately following heavy rains. Applications shall not be performed when conditions may cause runoff or create an environmental hazard. Applications shall not be performed when average wind speed exceeds 10 miles per hour. The termiticide shall not be allowed to enter water systems, aquifers, or endanger humans or animals.

1.4.2.1 Vapor Barriers and Waterproof Membranes

Termiticide shall be applied prior to placement of a vapor barrier or waterproof membrane.

1.4.2.2 Utilities and Vents

Prior to application, HVAC ducts and vents located in treatment area shall be turned off and blocked to protect people and animals from termiticide.

1.4.3 Placement of Concrete

Place concrete covering treated soils as soon as the termiticide has reached maximum penetration into the soil. Time for maximum penetration shall be as recommended by the manufacturer.

1.5 WARRANTY

The Contractor shall provide a 5-year written warranty against infestations or reinfestations by subterranean termites of the buildings or building additions constructed under this contract. Warranty shall include annual inspections of the buildings or building additions. If live subterranean termite infestation or subterranean termite damage is discovered during the warranty period, and the soil and building conditions have not been altered in the interim, the Contractor shall:

a. Retreat the soil and perform other treatment as may be necessary for elimination of subterranean termite infestation;

b. Repair damage caused by termite infestation; and

c. Reinspect the building approximately 180 days after the retreatment.

PART 2 PRODUCTS

## 2.1 TERMITICIDES

Provide termiticides currently registered by the EPA or approved for such use by the appropriate agency of the host county. Select non-repellant termiticide for maximum effectiveness and duration after application. The selected termiticide shall be suitable for the soil and climatic conditions at the project site.

# PART 3 EXECUTION

## 3.1 VERIFICATION OF MEASUREMENT

Once termiticide application has been completed, measure tank contents to determine the remaining volume. The total volume measurement of used contents for the application shall equal the established application rate for the project site conditions. Provide written verification of the measurements.

## 3.2 TECHNICAL REPRESENTATIVE

The certified installation pest management coordinator shall be the technical representative, shall be present at all meetings concerning treatment measures for subterranean termites, and may be present during treatment application. The command Pest Control Coordinator shall be contacted prior to starting work.

## 3.3 SITE PREPARATION

Site preparation shall be in accordance with specification covering earthwork and landscaping. Work related to final grades, landscape plantings, foundations, or any other alterations to finished construction which might alter the condition of treated soils, shall be coordinated with this specification.

### 3.3.1 Ground Preparation

Food sources shall be eliminated by removing debris from clearing and grubbing and post construction wood scraps such as ground stakes, form boards, and scrap lumber from the site, before termiticide application begins.

### 3.3.2 Verification

Before work starts, verify that final grades are as indicated and smooth grading has been completed in accordance with Section 31 23 00 EXCAVATION AND FILL. Soil particles shall be finely graded with particles no larger than 1 inch and compacted to eliminate soil movement to the greatest degree.

### 3.3.3 Foundation Exterior

Provide written verification that final grading and landscape planting operations will not disturb treatment of the soil on the exterior sides of foundation walls, grade beams, and similar structures.

3.3.4 Utilities and Vents

Provide written verification that the location and identity of HVAC ducts and vents, water and sewer lines, and plumbing have been accomplished prior to the termiticide application.

3.3.5 Application Plan

Submit a Termiticide Application Plan for approval before starting the specified treatment.

3.4 TERMITICIDE TREATMENT

3.4.1 Equipment Calibration and Tank Measurement

Submit a listing of equipment to be used. Immediately prior to commencement of termiticide application, calibration tests shall be conducted on the application equipment to be used and the application tank shall be measured to determine the volume and contents. These tests shall confirm that the application equipment is operating within the manufacturer's specifications and will meet the specified requirements. Submit written certification of the equipment calibration test results within 1 week of testing.

3.4.2 Mixing and Application

Formulating, mixing, and application shall be performed in the presence of the Contracting Officer's Representative. A closed system is recommended as it prevents the termiticide from coming into contact with the applicator or other persons. Water for formulating shall only come from designated locations. Filling hoses shall be fitted with a backflow preventer meeting local plumbing codes or standards. Overflow shall be prevented during the filling operation. Prior to each day of use, the equipment used for applying termiticides shall be inspected for leaks, clogging, wear, or damage. Any repairs are to be performed immediately.

3.4.3 Treatment Method

For areas to be treated, establish complete and unbroken vertical and/or horizontal soil poison barriers between the soil and all portions of the intended structure which may allow termite access to wood and wood related products. Application shall not be made to areas which serve as crawl spaces or for use as a plenum air space.

3.4.3.1 Surface Application

Use surface application for establishing horizontal barriers. Surface applicants shall be applied as a coarse spray and provide uniform distribution over the soil surface. Termiticide shall penetrate a minimum of 1 inch into the soil, or as recommended by the manufacturer.

#### 3.4.3.2 Rodding and Trenching

Use rodding and trenching for establishing vertical soil barriers. Trenching shall be to the depth of the foundation footing. Width of trench shall be as recommended by the manufacturer, or as indicated. Rodding or other approved method may be implemented for saturating the base of the trench with termiticide. Immediately after termiticide has reached maximum penetration as recommended by the manufacturer, backfilling of the trench shall commence. Backfilling shall be in 6 inch rises or layers. Each rise shall be treated with termiticide.

### 3.4.4 Sampling

The Contracting Officer's Representative may draw from stocks at the job site, at any time and without prior notice, take samples of the termiticides used to determine if the amount of active ingredient specified on the label is being applied.

## 3.5 CLEAN UP, DISPOSAL, AND PROTECTION

Once application has been completed, proceed with clean up and protection of the site without delay.

### 3.5.1 Clean Up

The site shall be cleaned of all material associated with the treatment measures, according to label instructions, and as indicated. Excess and waste material shall be removed and disposed off site.

### 3.5.2 Disposal of Termiticide

Dispose of residual termiticides and containers off Government property, and in accordance with label instructions and EPA criteria.

### 3.5.3 Protection of Treated Area

Immediately after the application, the area shall be protected from other use by erecting barricades and providing signage as required or directed.

## 3.6 CONDITIONS FOR SATISFACTORY TREATMENT

### 3.6.1 Equipment Calibrations and Measurements

Where results from the equipment calibration and tank measurements tests are unsatisfactory, re-treatment will be required.

### 3.6.2 Testing

Should an analysis, performed by a third party, indicate that the samples of the applied termiticide contain less than the amount of active ingredient specified on the label, and/or if soils are treated to a depth less than specified or approved, re-treatment will be required.

3.6.3 Disturbance of Treated Soils

Soil and fill material disturbed after treatment shall be re-treated before placement of slabs or other covering structures.

3.6.4 Termites Found Within the Warranty Period

If live subterranean termite infestation or termite damage is discovered during the warranty period, re-treat the site.

3.7 RE-TREATMENT

Where re-treatment is required, comply with the requirements specified in paragraph WARRANTY.

-- End of Section 31 31 16 --

SECTION 32 11 24
GRADED CRUSHED AGGREGATE BASE COURSE FOR PAVEMENT

PART 1 GENERAL

1.1 REFERENCES

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

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM C117 | (2013) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing |
| ASTM C136 | (2006) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates |
| ASTM D1556 | (2007) Density and Unit Weight of Soil in Place by the Sand-Cone Method |
| ASTM D1557 | (2012) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3) |
| ASTM D75/D75M | (2013) Standard Practice for Sampling Aggregates |

1.2 RELATED SECTIONS

Pervious pavement systems shall use Section 32 12 17 HOT MIX BITUMINOUS PAVEMENT in addition to this section.

1.3 SUBMITTALS

Contracting Officer's written approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-06 Test Reports

Gradation

Density

Smoothness

## 1.4 DELIVERY AND STORAGE

Inspect materials delivered to site for damage and store as to prevent segregation and contamination.

## 1.5 WEATHER LIMITATIONS

Do not construct base course when atmospheric temperature is below 35 degrees F or when rainfall or other weather conditions detrimentally affect the quality of the finished course.

## 1.6 CONSTRUCTION EQUIPMENT

Equipment shall be dependable and adequate for the purpose intended. Maintain equipment in satisfactory and safe operating condition. Subject to approval, special equipment dictated by local conditions may be used. Calibrated equipment, such as scales, batching equipment, spreaders, and similar items, shall have been recalibrated by a State calibration laboratory within 12 months of commencing work.

# PART 2 PRODUCTS

## 2.1 MATERIALS

The contractor shall provide material in accordance with the North Carolina Department of Transportation's Standard Specifications for Roads and Structures (2012), Section 520, Type "ABC".

# PART 3 EXECUTION

## 3.1 BASE COURSE

Construct the graded aggregate base course on a prepared subgrade, as indicated. Verify compacted subgrade, granular base, or stabilized soil is acceptable and ready to support paving and imposed loads. Provide line and grade stakes for control. Place grade stakes in lanes parallel to the centerline of areas to be paved and space for string lining or other control methods. The base course shall consist of aggregate processed, deposited, spread, and compacted on a prepared surface. The Contractor shall be responsible for protection of completed areas against detrimental effects. Recondition, reshape, and recompact areas damaged by freezing, rainfall, or other weather conditions.

## 3.2 PLACING

Do not dump mixed materials in piles, but place on prepared subgrade or subbase in layers of uniform thickness with a spreader. When a compacted course 6 inches in thickness is required, place material in a single layer. When a compacted course in excess of 6 inches is required, place material in layers of equal thickness. Do not exceed 6 inches or have less than 3 inches in thickness for any compacted layer. Place layers so that when compacted, they will be true to

grades or levels required with the least possible surface disturbance. Where the base course is constructed in more than one layer, clean previously constructed layers of loose and foreign matter. Maintain material water content during the placing period to obtain the compaction specified. Make adjustments in placing procedures or equipment to obtain true grades, to minimize segregation and degradation, to reduce or increase water content, and to insure a satisfactory base course.

## 3.3 COMPACTING AND FINISHING

Immediately following the placing, spread the finished mixture uniformly in a layer and bring to optimum moisture content. The loose thickness and the surface of the layer shall be such that the specified density and the required thickness shall be obtained after compaction. Compact the layer with steel-faced, vibrating or pneumatic-tired rollers, or other suitable compacting equipment or combinations thereof. Continue compacting until the layer is compacted through the full depth to a field density of at least 100 percent of the maximum density at optimum moisture content tested in accordance with ASTM D1556. In areas not accessible to rollers or compactors, compact the mixture with mechanical hand tampers. If the mixture is excessively moistened by rain, aerate by blade graders, or other suitable equipment. Aerate until the moisture content of the material is that needed to obtain the required density. Finish the surface of the layer by a combination of rolling and blading. Final surface shall be smooth and free from waves, irregularities, and ruts or soft yielding spots.

## 3.4 FIELD QUALITY CONTROL

Approve materials and material sources in advance of the use of such materials in the work. Replace base where samples are removed.

### 3.4.1 Sampling

#### 3.4.1.1 Aggregates at the Source

Prior to production and delivery of aggregates, take at least one initial sample in accordance with ASTM D75/D75M. Collect each sample by taking three incremental samples at random from the source material to make a composite sample of not less than 50 pounds. Repeat above sampling when source of material is changed or when unacceptable deficiencies or variations from specified grading of materials are found in testing.

#### 3.4.1.2 During Construction

Take one random sample from each day's run. Take samples in accordance with ASTM D75/D75M.

#### 3.4.1.3 Sample Identification

Place each sample in a clean container, securely fastened to prevent loss of material. Tag each sample for identification and with the following information:

Contract No._____
Sample No._____ Quality _____
Date of Sample_____
Sampler_____
Source_____
Intended Use_____
For Testing_____

3.4.2 Testing

3.4.2.1 Aggregates

Test each sample of base course material without delay. Make gradation tests from each sample in accordance with ASTM C136. Make sieve analysis on material passing the No. 200 sieve in accordance with ASTM C117.

3.4.2.2 Smoothness Tests

Test with a 10 foot straightedge, applied parallel with and at right angles to the center line of the paved area. Correct deviations in the surface in excess of 1/2 inch by loosening, adding or removing material, reshaping, watering, and compacting. The smoothness requirements specified herein apply only to the top layer when base course is constructed in more than one layer.

3.4.2.3 Field Density Tests

ASTM D1556. Take two test for each layer of base course.

3.4.2.4 Laboratory Density Tests

In accordance with ASTM D1557, Method D.

3.4.2.5 Thickness Tests

Measure thickness of base course at intervals such that there will be a depth measurement for at least each 100 square yards of complete base course. Make depth measurements by test holes, at least 3 inches in diameter, through the base course. Where base course deficiency is more than 1/2 inch, correct by scarifying, adding mixture of proper gradation, reblading, and recompacting. Where the measured thickness is more than 1/2 inch thicker than indicated, consider it as the indicated thickness plus 1/2 inch for determining the average. The average thickness is the average of the depth measurements and shall not underrun the thickness indicated.

3.5 MAINTENANCE

After construction is completed, maintain the base course throughout, except where portion of the succeeding course is under construction thereon. Maintenance includes drainage, rolling, shaping, and watering, as necessary, to maintain the course in proper condition. Correct deficiencies in thickness, composition, construction, smoothness, and density, which develop during the maintenance, to conform to the requirements specified herein. Maintain sufficient moisture by light sprinkling with water at the surface to prevent a dusty condition.

-- End of Section 32 11 24 --

SECTION 32 12 17
HOT MIX BITUMINOUS PAVEMENT

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

| | |
|---|---|
| AASHTO M 156 | (2013) Standard Specification for Requirements for Mixing Plants for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM C117 | (2013) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing |
| ASTM C136 | (2006) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates |
| ASTM D1188 | (2007; E 2010) Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Paraffin-Coated Specimens |
| ASTM D2172/D2172M | (2011) Quantitative Extraction of Bitumen from Bituminous Paving Mixtures |
| ASTM D2726/D2726M | (2013) Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures |
| ASTM D4867/D4867M | (2009) Effect of Moisture on Asphalt Concrete Paving Mixtures |
| ASTM D6927 | (2006) Standard Test Method for Marshall Stability and Flow of Bituminous Mixtures |
| ASTM D979/D979M | (2012) Sampling Bituminous Paving Mixtures |

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION (NC DOT)

| | |
|---|---|
| NC DOT SHS | (2012) North Carolina Department of Transportation Standard Specification for Roads and Structures |

## 1.2 SUBMITTALS

Contracting Officer's written approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-06 Test Reports

Bituminous mix tests

Pavement courses

SD-07 Certificates

Construction Equipment

Certifications

## 1.3 QUALITY ASSURANCE

Submit certifications that materials are supplied from NC DOT SHS pre-approved batch plant and job mix materials meeting NC DOT SHS standards. Indicate material types and proportions.

### 1.3.1 Charts

Plot and submit, on a grain size chart, the specified aggregate gradation band, the job-mix gradation and the job-mix tolerance band.

### 1.3.2 Selection of Optimum Asphalt Content

Base selection on percent of total mix and the average of values at the following points on the curves for each mix:

a. Stability: Peak

b. Unit Weight: Peak

c. Percent Air Voids: Median

## 1.4 DELIVERY, STORAGE, AND HANDLING

Inspect materials delivered to the site for damage and store with a minimum of handling. Store aggregates in such a manner as to prevent segregation, contamination, or intermixing of the different aggregate sizes.

## 1.5 ENVIRONMENTAL CONDITIONS

Place bituminous mixture only during dry weather and on dry surfaces. Place courses only when the surface temperature of the underlying course is greater than 45 degrees F for course thicknesses greater than one inch and 55 degrees F for course thicknesses one inch or less.

## 1.6 CONSTRUCTION EQUIPMENT

Calibrated equipment, such as scales, batching equipment, spreaders and similar equipment, shall have been recalibrated by a calibration laboratory approved by the Contracting Officer within 12 months of commencing work.

### 1.6.1 Mixing Plant

Design, coordinate, and operate the mixing plant to produce a mixture within the job-mix formula tolerances and to meet the requirements of AASHTO M 156, including additional plant requirements specified herein. The plant shall be a batch type, continuous mix type or drum-dryer mixer type, and shall have sufficient capacity to handle the new bituminous construction. Minimum plant capacity shall be 50 tons per hour. The mixing plant and equipment shall remain accessible at all times for inspecting operation, verifying weights, proportions and character of materials, and checking mixture temperatures. Plants must be prequalified by NC DOT SHS.

### 1.6.2 Paving Equipment

#### 1.6.2.1 Spreading Equipment

Self-propelled electronically controlled type, unless other equipment is authorized by the Contracting Officer. Equip spreading equipment of the self-propelled electronically controlled type with hoppers, tamping or vibrating devices, distributing screws, electronically adjustable screeds, and equalizing devices. Capable of spreading hot bituminous mixtures without tearing, shoving, or gouging and to produce a finished surface of specified grade and smoothness. Operate spreaders, when laying mixture, at variable speeds between 5 and 45 feet per minute. Design spreader with a quick and efficient steering device; a forward and reverse traveling speed; and automatic devices to adjust to grade and confine the edges of the mixture to true lines. The use of a spreader that leaves indented areas or other objectionable irregularities in the fresh laid mix during operations is prohibited.

#### 1.6.2.2 Rolling Equipment

Self-propelled pneumatic-tired rollers supplemented by three-wheel and tandem type steel wheel rollers. The number, type and weight of rollers shall be sufficient to compact the mixture to the required density without detrimentally affecting the compacted material. Rollers shall be suitable for rolling hot-mix bituminous pavements and capable of reversing without backlash. Pneumatic-tired rollers shall be capable of being operated both forward and backward without turning on the mat, and without loosening the surface being rolled. Equip rollers with suitable

devices and apparatus to keep the rolling surfaces wet and prevent adherence of bituminous mixture. Vibratory rollers especially designed for bituminous concrete compaction may be used provided rollers do not impair stability of pavement structure and underlying layers. Repair depressions in pavement surfaces resulting from use of vibratory rollers. Rollers shall be self-propelled, single or dual vibrating drums, and steel drive wheels, as applicable; equipped with variable amplitude and separate controls for energy and propulsion.

1.6.2.3 Hand Tampers

Minimum weight of 25 pounds with a tamping face of not more than 50 square inches.

1.6.2.4 Mechanical Hand Tampers

Commercial type, operated by pneumatic pressure or by internal combustion.

## PART 2 PRODUCTS

### 2.1 MATERIALS

The contractor shall provide materials in accordance with the North Carolina Department of Transportation's Standard Specifications for Roads and Structures (2012), Section 610 mix designation "SF9.5A" for wearing course, Section 610 mix designation "I 12.5B" for intermediate course, Section 600 for Prime Coat, Section 605 for Tack Coat.

## PART 3 EXECUTION

### 3.1 PREPARATION

#### 3.1.1 Preparation of Asphalt Binder Material

The asphalt cement material shall be heated avoiding local overheating and providing a continuous supply of the asphalt material to the mixer at a uniform temperature. The temperature of unmodified asphalts shall be no more than 160 degrees C 325 degrees F when added to the aggregates. Modified asphalts shall be no more than 174 degrees C 350 degrees F when added to the aggregate.

#### 3.1.2 Preparation of Mineral Aggregates

Store different size aggregate in separate stockpiles so that different sizes will not mix. Stockpile different-sized aggregates in uniform layers by use of a clam shell or other approved method so as to prevent segregation. The use of bulldozers in stockpiling of aggregate or in feeding aggregate to the dryer is prohibited. Feed aggregates into the cold elevator by means of separate mechanical feeders so that aggregates are graded within requirements of the job-mix formulas and tolerances specified. Regulate rates of feed of the aggregates so that moisture content and temperature of aggregates are within tolerances specified herein. Dry and heat aggregates to the

temperature necessary to achieve the mixture determined by the job mix formula within the job tolerance specified. Provide adequate dry storage for mineral filler.

### 3.1.3 Preparation of Bituminous Mixture

Accurately weigh aggregates and dry mineral filler and convey into the mixer in the proportionate amounts of each aggregate size required to meet the job-mix formula. In batch mixing, after aggregates and mineral filler have been introduced into the mixer and mixed for not less than 15 seconds, add asphalt by spraying or other approved methods and continue mixing for a period of not less than 20 seconds, or as long as required to obtain a homogeneous mixture. The time required to add or spray asphalt into the mixer will not be added to the total wet-mixing time provided the operation does not exceed 10 seconds and a homogeneous mixture is obtained. When a continuous mixer is employed, mixing time shall be more than 35 seconds to obtain a homogeneous mixture. Additional mixing time, when required, will be as directed by the Contracting Officer's Representative. When mixture is prepared in a twin-pugmill mixer, volume of the aggregates, mineral filler, and asphalt shall not extend above tips of mixer blades when blades are in a vertical position. Overheated and carbonized mixtures, or mixtures that foam or show indication of free moisture, will be rejected. When free moisture is detected in batch or continuous mix plant produced mixtures, waste the mix and withdraw the aggregates in the hot bins immediately and return to the respective stockpiles; for drum-dryer mixer plants, waste the mix, including that in surge or storage bins that is affected by free moisture.

### 3.1.4 Transportation of Bituminous Mixtures

Transport bituminous material from the mixing plant to the paving site in trucks having tight, clean, smooth beds that have been coated with a minimum amount of concentrated solution of hydrated lime and water or other approved coating to prevent adhesion of the mixture to the truck. Petroleum products will not be permitted for coating truck. If air temperature is less than 60 degrees F or if haul time is greater than 30 minutes, cover each load with canvas or other approved material of ample size to protect the mixture from the loss of heat. Make deliveries so that the spreading and rolling of all the mixture prepared for one day's run can be completed during daylight, unless adequate approved artificial lighting is provided. Deliver mixture to area to be paved so that the temperature at the time of dumping into the spreader is within the range specified herein. Reject loads that are below minimum temperature, that have crusts of cold unworkable material, or that have been wet excessively by rain. Hauling over freshly laid material is prohibited.

### 3.1.5 Surface Preparation of Underlying Course

Prior to the laying of the asphalt concrete, clean underlying course of foreign or objectionable matter with power blowers or power brooms, supplemented by hand brooms and other cleaning methods where necessary. During the placement of multiple lifts of bituminous concrete, each succeeding lift of bituminous concrete shall have its underlying lift cleaned and provided with a bituminous tack coat if the time period between the placement of each lift of bituminous concrete exceeds 14 days, or the underlying bituminous concrete has become dirty. Remove grass and other vegetative growth from existing cracks and surfaces.

### 3.1.6 Spraying of Contact Surfaces

Spray contact surfaces of previously constructed pavement with a thin coat of bituminous materials to act as an anti-stripping agent. Paint contact surfaces of structures with a thin coat of emulsion or other approved bituminous material prior to placing the bituminous mixture. Tack coat the previously placed primed coats on base courses when surface has become excessively dirty and cannot be cleaned or when primed surface has cured to the extent that it has lost all bonding effect.

## 3.2 PLACEMENT

### 3.2.1 Machine Spreading

The range of temperatures of the mixtures at the time of spreading shall be between 250 degrees F and 300 degrees F. Bituminous concrete having temperatures less than minimum spreading temperature when dumped into the spreader will be rejected. Adjust spreader and regulate speed so that the surface of the course is smooth and continuous without tears and pulling, and of such depth that, when compacted, the surface conforms with the cross section, grade, and contour indicated. Unless otherwise directed, begin the placing along the centerline of areas to be paved on a crowned section or on the high side of areas with a one-way slope. Place mixture in consecutive adjacent strips having a minimum width of 10 feet, except where the edge lanes require strips less than 10 feet to complete the area. Construct longitudinal joints and edges to true line markings. Establish lines parallel to the centerline of the area to be paved, and place string lines coinciding with the established lines for the spreading machine to follow. Provide the number and location of the lines needed to accomplish proper grade control. Place mixture as nearly continuous as possible and adjust the speed of placing as needed to permit proper rolling.

### 3.2.2 Shoveling, Raking, and Tamping After Machine-Spreading

Shovelers and rakers shall follow the spreading machine. Add or remove hot mixture and rake the mixture as required to obtain a course that when completed will conform to requirements specified herein. Broadcasting or fanning of mixture over areas being compacted is prohibited. When segregation occurs in the mixture during placing, suspend spreading operation until the cause is determined and corrected. Correct irregularities in alignment left by the spreader by trimming directly behind the machine. Immediately after trimming, compact edges of the course by tamping laterally with a metal lute or by other approved methods. Distortion of the course during tamping is prohibited.

### 3.2.3 Hand-Spreading in Lieu of Machine-Spreading

In areas where the use of machine spreading is impractical, spread mixture by hand. The range of temperatures of the mixtures when dumped onto the area to be paved shall be between 250 and 300 degrees F. Mixtures having temperatures less than minimum spreading temperature when dumped onto the area to be paved will be rejected. Spread hot mixture with rakes in a

uniformly loose layer of a thickness that, when compacted, will conform to the required grade, thickness, and smoothness. During hand spreading, place each shovelful of mixture by turning the shovel over in a manner that will prevent segregation. Do not place mixture by throwing or broadcasting from a shovel. Do not dump loads any faster than can be properly handled by the shovelers and rakers.

## 3.3 COMPACTION OF MIXTURE

Compact mixture by rolling. Begin rolling as soon as placement of mixture will bear rollers. Delays in rolling freshly spread mixture shall not be permitted. Start rolling longitudinally at the extreme sides of the lanes and proceed toward center of pavement, or toward high side of pavement with a one-way slope. Operate rollers so that each trip overlaps the previous adjacent strip by at least one foot. Alternate trips of the roller shall be of slightly different lengths. Conduct tests for conformity with the specified crown, grade and smoothness immediately after initial rolling. Before continuing rolling, correct variations by removing or adding materials as necessary. If required, subject course to diagonal rolling with the steel wheeled roller crossing the lines of the previous rolling while mixture is hot and in a compactible condition. Speed of the rollers shall be slow enough to avoid displacement of hot mixture. Correct displacement of mixture immediately by use of rakes and fresh mixture, or remove and replace mixture as directed. Continue rolling until roller marks are eliminated and course has a density of at least 96 percent but not more than 100 percent of that attained in a laboratory specimen of the same mixture prepared in accordance with ASTM D6927. During rolling, moisten wheels of the rollers enough to prevent adhesion of mixture to wheels, but excessive water is prohibited. Operation of rollers shall be by competent and experienced operators. Provide sufficient rollers for each spreading machine in operation on the job and to handle plant output. In places not accessible to the rollers, compact mixture thoroughly with hot hand tampers. Skin patching of an area after compaction is prohibited. Remove mixture that becomes mixed with foreign materials or is defective and replace with fresh mixture compacted to the density specified herein. Roller shall pass over unprotected edge of the course only when laying of course is to be discontinued for such length of time as to permit mixture to become cold.

## 3.4 JOINTS

Joints shall present the same texture and smoothness as other portions of the course, except permissible density at the joint may be up to 2 percent less than the specified course density. Carefully make joints between old and new pavement or within new pavements in a manner to ensure a thorough and continuous bond between old and new sections of the course. Vertical contact surfaces of previously constructed sections that are coated with dust, sand, or other objectionable material shall be painted with a thin uniform coat of emulsion or other approved bituminous material just before placing fresh mixture.

### 3.4.1 Transverse

Roller shall pass over unprotected end of freshly laid mixture only when laying of course is to be discontinued. Except when an approved bulkhead is used, cut back the edge of previously laid course to expose an even, vertical surface for the full thickness of the course. When required,

rake fresh mixture against joints, thoroughly tamp with hot tampers, smooth with hot smoothers, and roll. Transverse joints in adjacent lanes shall be offset a minimum of 2 feet.

3.4.2 Longitudinal Joints

Space 6 inches apart. Do not allow joints to coincide with joints of existing pavement or previously placed courses. Spreader screed shall overlap previously placed lanes 2 to 3 inches and be of such height to permit compaction to produce a smooth dense joint. With a lute, push back mixture placed on the surface of previous lanes to the joint edge. Do not scatter mix. Remove and waste excess material. When edges of longitudinal joints are irregular, honeycombed, or poorly compacted, cut back unsatisfactory sections of joint and expose an even vertical surface for the full thickness of the course. When required, rake fresh mixture against joint, thoroughly tamp with hot tampers, smooth with hot smoothers, and roll while hot.

3.5 FIELD QUALITY CONTROL

3.5.1 Sampling

3.5.1.1 Pavement and Mixture

Take plant samples for the determination of mix properties and field samples for thickness and density of the completed pavements. Furnish tools, labor and material for samples, and satisfactory replacement of pavement. Take samples and tests at not less than frequency specified hereinafter and at the beginning of plant operations; for each day's work as a minimum; each change in the mix or equipment; and as often as directed. Accomplish sampling in accordance with ASTM D979/D979M.

3.5.2 Testing

3.5.2.1 Bituminous Mix Tests

Test one sample for each day's run, or fraction thereof, of the uncompacted mix for extraction in accordance with ASTM D2172/D2172M; perform a sieve analysis on each extraction sample in accordance with ASTM C136 and ASTM C117. Test one sample for each 500 tons or fraction thereof for stability and flow in accordance with ASTM D6927. Test one sample for each material blend for Tensile Strength Ratio in accordance with ASTM D4867/D4867M.

3.5.2.2 Pavement Courses

Perform the following tests:

a. Density: For each day's run of bituminous mixture placed, determine the representative laboratory density by averaging the density of four laboratory specimens prepared in accordance with ASTM D6927. Samples for laboratory specimens shall be taken from trucks delivering mixture to the site; record in a manner approved by the Contracting Officer the project areas represented by the laboratory densities. From each representative

area recorded, determine field density of pavement by averaging densities of 4 inch diameter cores obtained from wearing course; take one core for each 300 square yards or fraction thereof of course placed. Determine density of laboratory prepared specimens and cored samples in accordance with ASTM D1188 or ASTM D2726/D2726M, as applicable. Separate pavement layers by sawing or other approved means. Maximum allowable deficiency at any point, excluding joints, shall not be more than 2 percent less than the specified density for any course. The average density of each course, excluding joints, shall be not less than the specified density. Joint densities shall not be more than 2 percent less than specified course densities and are not included when calculating average course densities. When the deficiency exceeds the specified tolerances, correct each such representative area or areas by removing the deficient pavement and replacing with new pavement.

b. Thickness: Determine thickness of wearing courses from samples taken for the field density test. The maximum allowable deficiency at any point shall not be more than 1/4 inch less than the thickness for the indicated course. Average thickness of course or of combined courses shall be not less than the indicated thickness. Where a deficiency exceeds the specified tolerances, correct each such representative area or areas by removing the deficient pavement and replacing with new pavement.

c. Smoothness: Straightedge test the compacted surface of wearing course as work progresses. Apply straightedge parallel with and at right angles to the centerline after final rolling. Variations in the wearing course shall not vary more than 1/8 inch in 10 feet. Correct each portion of the pavement showing irregularities greater than that specified.

d. Finish Surface Texture of Wearing Course: Visually check final surface texture for uniformity and reasonable compactness and tightness. Final wearing course with a surface texture having undesirable irregularities such as segregation, cavities, pulls or tears, checking, excessive exposure of coarse aggregates, sand streaks, indentations, ripples, or lack of uniformity shall be removed and replaced with new materials.

## 3.6 PROTECTION

Do not permit vehicular traffic, including heavy equipment, on pavement until surface temperature has cooled to at least 120 degrees F. Measure surface temperature by approved surface thermometers or other satisfactory methods.

-- End of Section 32 12 17 --

SECTION 32 13 13
PORTLAND CEMENT CONCRETE PAVEMENT FOR ROADS AND SITE FACILITIES

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN CONCRETE INSTITUTE INTERNATIONAL (ACI)

| | |
|---|---|
| ACI 301 | (2010; Errata 2011) Specifications for Structural Concrete |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM C1077 | (2014) Standard Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation |
| ASTM C143/C143M | (2012) Standard Test Method for Slump of Hydraulic-Cement Concrete |
| ASTM C171 | (2007) Standard Specification for Sheet Materials for Curing Concrete |
| ASTM C172/C172M | (2014) Standard Practice for Sampling Freshly Mixed Concrete |
| ASTM C231/C231M | (2014) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method |
| ASTM C309 | (2011) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete |
| ASTM C31/C31M | (2012) Standard Practice for Making and Curing Concrete Test Specimens in the Field |
| ASTM C78/C78M | (2012; E 2013) Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading) |
| ASTM C94/C94M | (2014a) Standard Specification for Ready-Mixed Concrete |

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION (NC DOT)

NC DOT SHS (2012) North Carolina Department of Transportation Standard Specification for Roads and Structures

1.2 RELATED SECTIONS

Portland cement concrete pavement shall use Section 32 11 24, in addition to this section.

1.3 SUBMITTALS

Contracting Officer's written approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Curing materials

SD-05 Design Data

Concrete mix design

Thirty days minimum prior to concrete placement, submit a mix design, with applicable tests, for each strength and type of concrete for approval. Submit a complete list of materials including type; brand; source and amount of cement, fly ash, slag, and admixtures; and applicable reference specifications. Provide mix proportion data using at least three different water-cement ratios for each type of mixture, which will produce a range of strength encompassing those required for each class and type of concrete required. Submittal shall clearly indicate where each mix design will be used when more than one mix design is submitted. Obtain acknowledgement of approvals prior to concrete placement. Submit a new mix design for each material source change.

SD-06 Test Reports

Laboratory Test Reports

Concrete slump tests

Air content tests

Flexural strength tests

SD-07 Certificates

Ready-mixed concrete plant

Batch tickets

## 1.4 DELIVERY, STORAGE, AND HANDLING

ASTM C94/C94M.

## 1.5 QUALITY ASSURANCE

### 1.5.1 Ready-mixed Concrete Plant Certification

Unless otherwise approved by the Contracting Officer, ready mixed concrete shall be produced and provided by a National Ready-Mix Concrete Association (NRMCA) certified plant. If a volumetric mobile mixer is used to produce the concrete, rather than ready-mixed concrete, the mixer(s) must conform to the standards of the Volumetric Mixer Manufacturers Bureau (VMMB). Verification shall be made by a current VMMB conformance plate affixed to the volumetric mixer equipment.

### 1.5.2 Required Information

Submit copies of laboratory test reports showing that the mix has been successfully tested to produce concrete with the properties specified and that mix will be suitable for the job conditions. The laboratory test reports shall include mill test and all other test for cementitious materials, aggregates, and admixtures. Provide maximum nominal aggregate size, combined aggregate gradation analysis, percentage retained and passing sieve, and a graph of percentage retained verses sieve size. Test reports shall be submitted along with the concrete mix design. Sampling and testing of materials, concrete mix design, sampling and testing in the field shall be performed by a commercial testing laboratory which conforms to ASTM C1077. The laboratory shall be approved in writing by the Contracting Officer.

### 1.5.3 Batch Tickets

ASTM C94/C94M. Submit mandatory batch ticket information for each load of ready-mixed concrete.

# PART 2 PRODUCTS

## 2.1 MATERIALS

### 2.1.1 Portland Cement Concrete Pavement

Provide in accordance with NC DOT SHS, Section 700, Class "Pavment".

### 2.1.2 Curing Materials

#### 2.1.2.1 White-Burlap-Polyethylene Sheet

ASTM C171, 0.004 inch thick white opaque polyethylene bonded to 10 oz/linear yard (40 inch) wide burlap.

2.1.2.2 Liquid Membrane-Forming Compound

ASTM C309, white pigmented, Type 2, Class B, free of paraffin or petroleum.

2.1.3 Joint Fillers and Sealants

Provide in accordance with NC DOT SHS, Section 700.

2.2 CONTRACTOR-FURNISHED MIX DESIGN

Provide a mix design in accordance with NC DOT SHS, Section 700.

PART 3 EXECUTION

3.1 FORMS

3.1.1 Construction

Construction shall comply with NC DOT SHS, Section 700.

3.2 PAVING

3.2.1 Fixed Form Paving

Forms shall be steel. Forms may be built up with metal or wood, added only to the base, to provide an increase in depth of not more than 25 percent. The base width of the form shall be not less than eight-tenths of the vertical height of the form, except that forms 8 inches or less in vertical height shall have a base width not less than the vertical height of the form. Forms shall be set on firm material cut true to grade so that each form section when placed will be firmly in contact with the underlying layer for its entire base. Forms shall not be set on blocks or on built-up spots of underlying material. Forms shall remain in place at least 12 hours after the concrete has been placed. Forms shall be removed without injuring the concrete.

3.3 FINISHING CONCRETE

3.3.1 Texturing

3.3.1.1 Burlap Drag Finish

Before concrete becomes non-plastic, finish the surface of the slab by dragging on the surface a strip of clean, wet burlap measuring from 3 to 10 feet long and 2 feet wider than the width of the pavement. Select dimension of burlap drag so that at least 3 feet of the material is in contact

with the pavement. Drag the surface so as to produce a finished surface with a fine granular or sandy texture without leaving disfiguring marks.

3.3.1.2 Wire-Comb Texturing

Surface texture transverse to the pavement center line shall be applied using a mechanical wire comb drag. The comb shall be capable of traversing the full width of the pavement in a single pass at a uniform speed and with a uniform pressure. Successive passes of the comb shall be overlapped the minimum necessary to obtain a continuous and uniformly textured surface. The scores shall be 1/16 to 3/16 inch deep, 1/16 to 1/8 inch wide, and spaced 3/8 inch apart.

3.3.2 Repair of Surface Defects

Follow guidance of ACI 301.

3.4 CURING AND PROTECTION

Protect concrete adequately from injurious action by sun, rain, flowing water, frost, mechanical injury, tire marks and oil stains, and do not allow it to dry out from the time it is placed until the expiration of the minimum curing periods specified herein. Use White-Burlap-Polyethylene Sheet or liquid membrane-forming compound, except as specified otherwise herein. Do not use membrane-forming compound on surfaces where its appearance would be objectionable, on surfaces to be painted, where coverings are to be bonded to concrete, or on concrete to which other concrete is to be bonded. Maintain temperature of air next to concrete above 40 degrees F for the full curing periods.

3.4.1 White-Burlap-Polyethylene Sheet

Wet entire exposed surface thoroughly with a fine spray of water, saturate burlap but do not have excessive water dripping off the burlap and then cover concrete with White-Burlap-Polyethylene Sheet, burlap side down. Lay sheets directly on concrete surface and overlap 12 inches. Make sheeting not less than 18 inches wider than concrete surface to be cured, and weight down on the edges and over the transverse laps to form closed joints. Repair or replace sheets when damaged during curing. Check daily to assure burlap has not lost all moisture. If moisture evaporates, resaturate burlap and re-place on pavement (re-saturation and re-placing shall take no longer than 10 minutes per sheet). Leave sheeting on concrete surface to be cured for at least 7 days.

3.4.2 Liquid Membrane-Forming Compound Curing

Apply compound immediately after surface loses its water sheen and has a dull appearance and before joints are sawed. Agitate curing compound thoroughly by mechanical means during use and apply uniformly in a two-coat continuous operation by suitable power-spraying equipment. Total coverage for the two coats shall be at least one gallon of undiluted compound per 200 square feet. Compound shall form a uniform, continuous, coherent film that will not check, crack, or peel and shall be free from pinholes or other imperfections. Apply an additional coat of compound immediately to areas where film is defective. Respray concrete surfaces that are

subject to heavy rainfall within 3 hours after curing compound has been applied in the same manner.

3.4.2.1 Protection of Treated Surfaces

Keep concrete surfaces to which liquid membrane-forming compounds have been applied free from vehicular traffic and other sources of abrasion for not less than 72 hours. Foot traffic is allowed after 24 hours for inspection purposes. Maintain continuity of coating for entire curing period and repair damage to coating immediately.

3.5 FIELD QUALITY CONTROL

3.5.1 Sampling

The Contractor's approved laboratory shall collect samples of fresh concrete in accordance with ASTM C172/C172M during each working day as required to perform tests specified herein. Make test specimens in accordance with ASTM C31/C31M.

3.5.2 Consistency Tests

The Contractor's approved laboratory shall perform concrete slump tests in accordance with ASTM C143/C143M. Take samples for slump determination from concrete during placement. Perform tests at the beginning of a concrete placement operation and and for each batch (minimum) or every 20 cubic yards (maximum) of concrete to ensure that specification requirements are met. In addition, perform tests each time test beams and cylinders are made.

3.5.3 Flexural Strength Tests

The Contractor's approved laboratory shall test for flexural strength in accordance with ASTM C78/C78M. Make four test specimens for each set of tests. Test two specimens at 7 days, and the other two at 28 days. Concrete strength will be considered satisfactory when the minimum of the 28-day test results equals or exceeds the specified 28-day flexural strength, and no individual strength test is less than 650 pounds per square inch. If the ratio of the 7-day strength test to the specified 28-day strength is less than 65 percent, make necessary adjustments for conformance. Frequency of flexural tests on concrete beams shall be not less than four test beams for each 50 cubic yards of concrete, or fraction thereof, placed. Concrete which is determined to be defective, based on the strength acceptance criteria therein, shall be removed and replaced with acceptable concrete.

3.5.4 Air Content Tests

Test air-entrained concrete for air content at the same frequency as specified for slump tests. Determine percentage of air in accordance with ASTM C231/C231M on samples taken during placement of concrete in forms.

-- End of Section 32 13 13 --

SECTION 32 92 19
SEEDING

PART 1 GENERAL

1.1 REFERENCES

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

U.S. DEPARTMENT OF AGRICULTURE (USDA)

| | |
|---|---|
| AMS Seed Act | (1940; R 1988; R 1998) Federal Seed Act |

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION (NC DOT)

| | |
|---|---|
| NC DOT SHS | (2012) North Carolina Department of Transportation Standard Specification for Roads and Structures |

1.2 DEFINITIONS

1.2.1 Stand of Turf

95 percent ground cover of the established species.

1.3 RELATED REQUIREMENTS

Section 31 23 00 EXCAVATION AND FILL.

1.4 SUBMITTALS

Contracting Officer's written approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Wood cellulose fiber mulch

Fertilizer

Include physical characteristics, and recommendations.

SD-07 Certificates

State certification and approval for seed

## 1.5 DELIVERY, STORAGE, AND HANDLING

### 1.5.1 Delivery

#### 1.5.1.1 Seed Protection

Protect from drying out and from contamination during delivery, on-site storage, and handling.

#### 1.5.1.2 Fertilizer and Lime Delivery

Deliver to the site in original, unopened containers bearing manufacturer's chemical analysis, name, trade name, trademark, and indication of conformance to state and federal laws. Instead of containers, fertilizer and lime may be furnished in bulk with certificate indicating the above information.

### 1.5.2 Storage

#### 1.5.2.1 Seed, Fertilizer and Lime Storage

Store in cool, dry locations away from contaminants.

#### 1.5.2.2 Topsoil

Prior to stockpiling topsoil, treat growing vegetation with application of appropriate specified non-selective herbicide. Clear and grub existing vegetation three to four weeks prior to stockpiling topsoil.

#### 1.5.2.3 Handling

Do not drop or dump materials from vehicles.

## 1.6 TIME RESTRICTIONS AND PLANTING CONDITIONS

### 1.6.1 Restrictions

Do not plant when the ground is frozen, snow covered, muddy, or when air temperature exceeds 90 degrees Fahrenheit.

## 1.7 TIME LIMITATIONS

### 1.7.1 Seed

Apply seed within twenty four hours after seed bed preparation.

# PART 2 PRODUCTS

## 2.1 SEED

Seed shall be provided in accordance with NC DOT SHS, Section 1660, subject to frequent mowing.

### 2.1.1 Classification

Provide State-approved, Endophyte-enhanced seed of the latest season's crop delivered in original sealed packages, bearing producer's guaranteed analysis for percentages of mixtures, purity, germination, weedseed content, and inert material. Label in conformance with AMS Seed Act and applicable state seed laws. Wet, moldy, or otherwise damaged seed will be rejected. Field mixes will be acceptable when field mix is performed on site in the presence of the Contracting Officer's Representative.

### 2.1.2 Planting Dates

Planting dates shall be in accordance with the requirements of NC DOT SHS, Section 1660 and the following table. Subject to frequent mowing.

Application Rate Per Acre

| March1-August 31 | September 1-February 28 |
|---|---|
| 25# Bermudagrass | 35# Bermudagrass |
| 6# Indiangrass | 6# Indiangrass |
| 8# Little Bluestem | 8# Little Bluestem |
| 4# Switchgrass | 4# Switchgrass |
| 25# Brownstop Millet | 35# Rye Grain |

### 2.1.3 Seed Purity

Seed purity shall be in accordance with requirements of NC DOT SHS, Section 1660.

### 2.1.4 Seed Mixture by Weight

Proportion seed mixtures by weight.

## 2.2 TOPSOIL

### 2.2.1 On-Site Topsoil

Surface soil stripped and stockpiled on site and modified as necessary to meet the requirements specified for topsoil in paragraph entitled "Composition." When available topsoil shall be existing surface soil stripped and stockpiled on-site in accordance with Section 31 23 00 EXCAVATION AND FILL.

2.2.2 Off-Site Topsoil

Conform to requirements specified in paragraph entitled "Composition." Additional topsoil shall be furnished by the Contractor.

2.2.3 Composition

Containing from 5 to 10 percent organic matter as determined by the topsoil composition tests of the Organic Carbon, 6A, Chemical Analysis Method described in DOA SSIR 42. Maximum particle size, 3/4 inch, with maximum 3 percent retained on 1/4 inch screen. The pH shall be tested in accordance with ASTM D 4972. Topsoil shall be free of sticks, stones, roots, and other debris and objectionable materials. Other components shall conform to the following limits:

| | |
|---|---|
| Silt | 25-50 percent |
| Clay | 10-30 percent |
| Sand | 20-35 percent |
| pH | 5.5 to 7.0 |
| Soluble Salts | 600 ppm maximum |

2.3 SOIL CONDITIONERS

Add conditioners to topsoil as required to bring into compliance with "composition" standard for topsoil as specified herein.

2.3.1 Lime

Commercial grade hydrate or burnt limestone containing a calcium carbonate equivalent (C.C.E.) as specified in ASTM C 602 of not less than 110 percent.

2.4 FERTILIZER

2.4.1 Granular Fertilizer

Synthetic, granular controlled release fertilizer containing the following minimum percentages, by weight, of plant food nutrients:

8 percent available nitrogen
8 percent available phosphorus
8 percent available potassium

2.4.2 Hydroseeding Fertilizer

Controlled release fertilizer, to use with hydroseeding and composed of pills coated with plastic resin to provide a continuous release of nutrients for at least 6 months and containing the following minimum percentages, by weight, of plant food nutrients.

8 percent available nitrogen
8 percent available phosphorus
8 percent available potassium

## 2.5 MULCH

Mulch shall be free from noxious weeds, mold, and other deleterious materials.

### 2.5.1 Straw

Stalks from oats, wheat, rye, barley, or rice. Furnish in air-dry condition and of proper consistency for placing with commercial mulch blowing equipment. Straw shall contain no fertile seed.

### 2.5.2 Hay

Air-dry condition and of proper consistency for placing with commercial mulch blowing equipment. Hay shall be sterile, containing no fertile seed.

### 2.5.3 Wood Cellulose Fiber Mulch

Use recovered materials of either paper-based (100 percent) or wood-based (100 percent) hydraulic mulch. Processed to contain no growth or germination-inhibiting factors and dyed an appropriate color to facilitate visual metering of materials application. Composition on air-dry weight basis: 9 to 15 percent moisture, pH range from 5.5 to 8.2. Use with hydraulic application of grass seed and fertilizer.

## 2.6 WATER

Source of water shall be approved by Contracting Officer’s Representative and of suitable quality for irrigation, containing no elements toxic to plant life.

# PART 3 EXECUTION

## 3.1 PREPARATION

### 3.1.1 EXTENT OF WORK

Provide soil preparation (including soil conditioners as required), fertilizing, seeding, and surface topdressing of all newly graded finished earth surfaces, unless indicated otherwise, and at all areas inside or outside the limits of construction that are disturbed by the Contractor's operations.

#### 3.1.1.1 Topsoil

Provide 4 inches of on-site topsoil to meet indicated finish grade. After areas have been brought to indicated finish grade, incorporate fertilizer pH adjusters and soil conditioners into soil a

minimum depth of 4 inches by disking, harrowing, tilling or other method approved by the Contracting Officer's Representative. Remove debris and stones larger than 3/4 inch in any dimension remaining on the surface after finish grading. Correct irregularities in finish surfaces to eliminate depressions. Protect finished topsoil areas from damage by vehicular or pedestrian traffic.

3.1.1.2 Soil Conditioner Application Rates

Apply soil conditioners at rates as determined by laboratory soil analysis of the soils at the job site. For bidding purposes only apply at rates for the following:

Lime, approximately 75 pounds per 1000 square feet.

3.1.1.3 Fertilizer Application Rates

Apply fertilizer at rates as determined by laboratory soil analysis of the soils at the job site. For bidding purposes only apply at rates for the following:

Synthetic Fertilizer 1500 pounds per acre .

Hydroseeding Fertilizer 800 pounds per acre.

3.2 SEEDING

3.2.1 Seed Application Seasons and Conditions

Immediately before seeding, restore soil to proper grade. Do not seed when ground is muddy frozen, snow covered or in an unsatisfactory condition for seeding. If special conditions exist that may warrant a variance in the above seeding dates or conditions, submit a written request to the Contracting Officer's Representative stating the special conditions and proposed variance. Apply seed within twenty four hours after seedbed preparation. Sow seed by approved sowing equipment. Sow one-half the seed in one direction, and sow remainder at right angles to the first sowing.

3.2.2 Seed Application Method

Seeding method shall be broadcasted and drop seeding or hydroseeding.

3.2.2.1 Broadcast and Drop Seeding

Seed shall be uniformly broadcast at the rate indicated in NC DOT SHS, pounds per 1000 square feet. Use broadcast or drop seeders. Sow one-half the seed in one direction, and sow remainder at right angles to the first sowing. Cover seed uniformly to a maximum depth of 1/4 inch in clay soils and 1/2 inch in sandy soils by means of spike-tooth harrow, cultipacker, raking or other approved devices.

3.2.2.2 Hydroseeding

First, mix water and fiber. Wood cellulose fiber, paper fiber, or recycled paper shall be applied as part of the hydroseeding operation. Fiber shall be added at 1,000 pounds, dry weight, per acre. Then add and mix seed and fertilizer to produce a homogeneous slurry. Seed shall be mixed to ensure broadcasting at the rate of pounds per 1000 square feet. When hydraulically sprayed on the ground, material shall form a blotter like cover impregnated uniformly with grass seed. Spread with one application with no second application of mulch.

3.2.3 Mulching

3.2.3.1 Hay or Straw Mulch

Hay or straw mulch shall be spread uniformly at the rate of 2 tons per acre. Mulch shall be spread by hand, blower-type mulch spreader, or other approved method. Mulching shall be started on the windward side of relatively flat areas or on the upper part of steep slopes, and continued uniformly until the area is covered. The mulch shall not be bunched or clumped. Sunlight shall not be completely excluded from penetrating to the ground surface. All areas installed with seed shall be mulched on the same day as the seeding. Mulch shall be anchored immediately following spreading.

3.2.3.2 Non-Asphaltic Tackifier

Hydrophilic colloid shall be applied at the rate recommended by the manufacturer, using hydraulic equipment suitable for thoroughly mixing with water. A uniform mixture shall be applied over the area.

3.2.4 Rolling

Immediately after seeding, firm entire area except for slopes in excess of 3 to 1 with a roller not exceeding 90 pounds for each foot of roller width. If seeding is performed with cultipacker-type seeder or by hydroseeding, rolling may be eliminated.

3.2.5 Erosion Control Material

Install in accordance with manufacturer's instructions, where indicated or as directed by the Contracting Officer's Representative.

3.2.6 Watering

Start watering areas seeded as required by temperature and wind conditions. Apply water at a rate sufficient to insure thorough wetting of soil to a depth of 2 inches without run off. During the germination process, seed is to be kept actively growing and not allowed to dry out.

3.3 PROTECTION OF TURF AREAS

Immediately after turfing, protect area against traffic and other use.

-- End of Section 32 92 19 --

SECTION 33 11 00
WATER DISTRIBUTION

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN WATER WORKS ASSOCIATION (AWWA)

| | |
|---|---|
| AWWA B300 | (2010; Addenda 2011) Hypochlorites |
| AWWA B301 | (2010) Liquid Chlorine |
| AWWA C600 | (2010) Installation of Ductile-Iron Water Mains and Their Appurtenances |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM D1785 | (2012) Standard Specification for Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120 |
| ASTM D2241 | (2009) Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series) |
| ASTM D2464 | (2013) Standard Specification for Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80 |
| ASTM D2466 | (2013) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40 |
| ASTM D2467 | (2013a) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80 |
| ASTM D2564 | (2012) Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems |
| ASTM D2774 | (2012) Underground Installation of Thermoplastic Pressure Piping |
| ASTM D2855 | (1996; R 2010) Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings |

| | |
|---|---|
| ASTM F402 | (2005; R 2012) Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings |

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

| | |
|---|---|
| MSS SP-80 | (2013) Bronze Gate, Globe, Angle and Check Valves |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 704 | (2012) Standard System for the Identification of the Hazards of Materials for Emergency Response |

UNI-BELL PVC PIPE ASSOCIATION (UBPPA)

| | |
|---|---|
| UBPPA UNI-B-3 | (1992) Recommended Practice for the Installation of Polyvinyl Chloride (PVC) Pressure Pipe (Nominal Diameters 4-36 Inch) |

## 1.2 SUBMITTALS

Contracting Officer's written approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Piping Materials

Water service line piping, fittings, joints, valves, and coupling

SD-06 Test Reports

Bacteriological Disinfection

Test results from commercial laboratory verifying disinfection

SD-08 Manufacturer's Instructions

Installation procedures for water piping

## 1.3 DELIVERY, STORAGE, AND HANDLING

### 1.3.1 Delivery and Storage

Inspect materials delivered to site for damage. Unload and store with minimum handling. Store materials on site in enclosures or under protective covering. Store plastic piping, jointing materials and rubber gaskets under cover out of direct sunlight. Do not store materials directly on the ground. Keep inside of pipes, fittings, valves and hydrants free of dirt and debris.

1.3.2 Handling

Handle pipe, fittings, valves, and other accessories in a manner to ensure delivery to the trench in sound undamaged condition. Take special care to avoid injury to coatings and linings on pipe and fittings; make repairs if coatings or linings are damaged. Do not place any other material or pipe inside a pipe or fitting after the coating has been applied. Carry, do not drag pipe to the trench. Use of pinch bars and tongs for aligning or turning pipe will be permitted only on the bare ends of the pipe. The interior of pipe and accessories shall be thoroughly cleaned of foreign matter before being lowered into the trench and shall be kept clean during laying operations by plugging or other approved method. Before installation, the pipe shall be inspected for defects. Material found to be defective before or after laying shall be replaced with sound material without additional expense to the Government. Store rubber gaskets that are not to be installed immediately, under cover out of direct sunlight.

1.3.2.1 Miscellaneous Plastic Pipe and Fittings

Handle Polyvinyl Chloride (PVC) pipe and fittings in accordance with the manufacturer's recommendations. Store plastic piping and jointing materials that are not to be installed immediately under cover out of direct sunlight.

Storage facilities shall be classified and marked in accordance with NFPA 704, with classification as indicated in NFPA 49 and NFPA 325.

PART 2 PRODUCTS

2.1 WATER SERVICE LINE MATERIALS

2.1.1 Piping Materials

2.1.1.1 Plastic Piping

Plastic pipe and fittings shall bear the seal of the National Sanitation Foundation (NSF) for potable water service. Plastic pipe and fittings shall be supplied from the same manufacturer.

a. Polyvinyl Chloride (PVC) Plastic Piping with Screw Joints: ASTM D1785, Schedule 40; or ASTM D2241, with SDR as necessary to provide 150 psi minimum pressure rating. Fittings, ASTM D2466 or ASTM D2467. Pipe and fittings shall be of the same PVC plastic material and shall be one of the following pipe/fitting combinations, as marked on the pipe and fitting, respectively: PVC 1120/PVC I; PVC 1220/PVC 12; PVC 2120/PVC II; PVC 2116/PVC II. Solvent cement for jointing, ASTM D2564. Pipe couplings, when used shall be tested as required by ASTM D2464.

b. Polyvinyl Chloride (PVC) Plastic Piping with Elastomeric-Gasket Joints:

Pipe shall conform to dimensional requirements of ASTM D1785 Schedule 40, with joints meeting the requirements of 150 psi working pressure, 200 psi hydrostatic test pressure, unless otherwise shown or specified.

c. Polyvinyl Chloride (PVC) Plastic Piping with Solvent Cement Joints:

Pipe shall conform to dimensional requirements of ASTM D1785 or ASTM D2241 with joints meeting the requirements of 150 psi working pressure and 200 psi hydrostatic test pressure.

2.1.1.2 Insulating Joints

Joints between pipe of dissimilar metals shall have a rubber-gasketed or other suitable approved type of insulating joint or dielectric coupling which will effectively prevent metal-to-metal contact between adjacent sections of piping.

2.1.2 Water Service Line Appurtenances

2.1.2.1 Gate Valves Smaller Than 3 Inch Size in Valve Boxes

MSS SP-80, Class 150, solid wedge, inside screw, rising stem. Valves shall have flanged or threaded end connections, with a union on one side of the valve and a handwheel operator.

2.1.2.2 Valve Boxes

Provide a valve box for each gate valve on buried piping. Valve boxes shall be of cast iron or precast concrete of a size suitable for the valve on which it is to be used and shall be adjustable. Precast concrete boxes installed in locations subjected to vehicular traffic shall be designed to withstand the following HS 20 AASHTO load designation as outline in AASHTO HB-17. Provide a round head. Cast the word "WATER" on the lid. The least diameter of the shaft of the box shall be 5 1/4 inches. Cast-iron box shall have a heavy coat of bituminous paint.

2.1.2.3 Disinfection

Chlorinating materials shall conform to the following:

Chlorine, Liquid: AWWA B301.

Hypochlorite, Calcium and Sodium: AWWA B300.

PART 3 EXECUTION

## 3.1 INSTALLATION OF PIPELINES

### 3.1.1 General Requirements for Installation of Pipelines

These requirements shall apply to all pipeline installation except where specific exception is made in the "Special Requirements..." paragraphs.

#### 3.1.1.1 Location of Water Lines

Terminate the work covered by this section at a point approximately 5 feet from the building. Where the location of the water line is not clearly defined by dimensions on the drawings, do not lay water line closer horizontally than 10 feet from any sewer line. Where water lines cross under gravity sewer lines, encase sewer line fully in concrete for a distance of at least 10 feet on each side of the crossing, unless sewer line is made of pressure pipe with rubber-gasketed joints and no joint is located within 3 feet horizontally of the crossing. Lay water lines which cross sewer force mains at least 2 feet above these sewer lines; when joints in the sewer line are closer than 3 feet horizontally from the water line, encase these joints in concrete.

Where water piping is required to be installed within 3 feet of existing structures, the water pipe shall be sleeved as required in Paragraph "Casting Pipe". The Contractor shall install the water pipe and sleeve ensuring that there will be no damage to the structures and no settlement or movement of foundations or footings.

Terminate the work covered by this section at a point approximately 5 feet from the building. Do not lay water lines in the same trench with gas lines or electric wiring.

a. Water Piping Installation Parallel With Sewer Piping

1. Normal Conditions: Lay water piping at least 10 feet horizontally from a sewer or sewer manhole whenever possible. Measure the distance edge-to-edge.

2. Unusual Conditions: When local conditions prevent a horizontal separation of 10 feet, the water piping may be laid closer to a sewer or sewer manhole provided that:

   (a) The bottom (invert) of the water piping shall be at least 18 inches above the top (crown) of the sewer piping.

   (b) Where this vertical separation cannot be obtained, the sewer piping shall be constructed of AWWA-approved water pipe and pressure tested in place without leakage prior to backfilling. Approved waste water disposal method shall be utilized.

   (c) The sewer manhole shall be of watertight construction and tested in place.

b. Installation of Water Piping Crossing Sewer Piping

(1) Normal Conditions: Water piping crossing above sewer piping shall be laid to provide a separation of at least 18 inches between the bottom of the water piping and the top of the sewer piping.

(2) Unusual Conditions: When local conditions prevent a vertical separation described above, use the following construction:

(a) Sewer piping passing over or under water piping shall be constructed of AWWA-approved ductile iron water piping, pressure tested in place without leakage prior to backfilling.

(b) Water piping passing under sewer piping shall, in addition, be protected by providing a vertical separation of at least 18 inches between the bottom of the sewer piping and the top of the water piping; adequate structural support for the sewer piping to prevent excessive deflection of the joints and the settling on and breaking of the water piping; and that the length, minimum 20 feet, of the water piping be centered at the point of the crossing so that joints shall be equidistant and as far as possible from the sewer piping.

c. Sewer Piping or Sewer Manholes: No water piping shall pass through or come in contact with any part of a sewer manhole.

3.1.1.2 Earthwork

Perform earthwork operations in accordance with Section 31 23 00 EXCAVATION AND FILL.

3.1.1.3 Pipe Laying and Jointing

Remove fins and burrs from pipe and fittings. Before placing in position, clean pipe, fittings, valves, and accessories, and maintain in a clean condition. Provide proper facilities for lowering sections of pipe into trenches. Do not under any circumstances drop or dump pipe, fittings, valves, or any other water line material into trenches. Cut pipe in a neat workmanlike manner accurately to length established at the site and work into place without springing or forcing. Replace by one of the proper length any pipe or fitting that does not allow sufficient space for proper installation of jointing material. Blocking or wedging between bells and spigots will not be permitted. Lay bell-and-spigot pipe with the bell end pointing in the direction of laying. Grade the pipeline in straight lines; avoid the formation of dips and low points. Support pipe at proper elevation and grade. Secure firm, uniform support. Wood support blocking will not be permitted. Lay pipe so that the full length of each section of pipe and each fitting will rest solidly on the pipe bedding; excavate recesses to accommodate bells, joints, and couplings. Provide anchors and supports where necessary for fastening work into place. Make proper provision for expansion and contraction of pipelines. Keep trenches free of water until joints have been properly made. At the end of each work day, close open ends of pipe temporarily with wood blocks or bulkheads. Do not lay pipe when conditions of trench or weather prevent installation. Depth of cover over top of pipe shall not be less than 2 1/2 feet.

3.1.1.4 Installation of Tracer Wire

Install a continuous length of tracer wire for the full length of each run of nonmetallic pipe. Attach wire to top of pipe in such manner that it will not be displaced during construction operations.

3.1.1.5 Connections to Existing Water Lines

Make connections to existing water lines after approval is obtained and with a minimum interruption of service on the existing line. Make connections to existing lines under pressure in accordance with the recommended procedures of the manufacturer of the pipe being tapped.

3.1.1.6 Penetrations

Pipe passing through walls of valve pits and structures shall be provided with ductile-iron or Schedule 40 steel wall sleeves. Annular space between walls and sleeves shall be filled with rich cement mortar. Annular space between pipe and sleeves shall be filled with mastic.

3.1.1.7 Flanged Pipe

Flanged pipe shall only be installed above ground or with the flanges in valve pits.

3.1.2 Installation of Water Service Piping

3.1.2.1 Location

Connect water service piping to the building service where the building service has been installed. Where building service has not been installed, terminate water service lines approximately 5 feet from the building line at the points indicated; such water service lines shall be closed with plugs or caps until tied to the buildings plumbing system.

3.1.3 Special Requirements for Installation of Water Service Piping

3.1.3.1 Installation of Plastic Piping

Install pipe and fittings in accordance with paragraph entitled "General Requirements for Installation of Pipelines" and with the applicable requirements of ASTM D2774 and ASTM D2855, unless otherwise specified. Handle solvent cements used to join plastic piping in accordance with ASTM F402.

a. Jointing: Make solvent-cemented joints for PVC plastic piping using the solvent cement previously specified for this material; assemble joints in accordance with ASTM D2855. Make plastic pipe joints to other pipe materials in accordance with the recommendations of the plastic pipe manufacturer.

b. Plastic Pipe Connections to Appurtenances: Connect plastic pipe service lines to gate valves in accordance with the recommendations of the plastic pipe manufacturer.

### 3.1.4 Disinfection

Prior to disinfection, obtain Contracting Officer's Representative's approval of the proposed method for disposal of waste water from disinfection procedures. Disinfect new water piping and existing water piping affected by Contractor's operations in accordance with AWWA C651. Fill piping systems with solution containing minimum of 50 parts per million of available chlorine and allow solution to stand for minimum of 24 hours. Flush solution from the systems with domestic water until maximum residual chlorine content is within the range of 0.2 and 0.5 parts per million, or the residual chlorine content of domestic water supply. Obtain at least two consecutive satisfactory bacteriological samples from new water piping, analyze by a certified laboratory, and submit the results prior to the new water piping being placed into service. Disinfection of systems supplying nonpotable water is not required.

## 3.2 FIELD QUALITY CONTROL

### 3.2.1 Field Tests and Inspections

Prior to hydrostatic testing, obtain Contracting Officer's Representative's approval of the proposed method for disposal of waste water from hydrostatic testing. The Contracting Officer's Representative will conduct field inspections and witness field tests specified in this section. The Contractor shall perform field tests, and provide labor, equipment, and incidentals required for testing. The Contractor shall produce evidence, when required, that any item of work has been constructed in accordance with the drawings and specifications.

### 3.2.2 Testing Procedure

Test water mains and water service lines in accordance with the applicable specified standard, except for the special testing requirements given in paragraph entitled "Special Testing Requirements." Test ductile-iron water mains and water service lines in accordance with the requirements of AWWA C600 for hydrostatic testing. The amount of leakage on ductile-iron pipelines with mechanical-joints or push-on joints shall not exceed the amounts given in AWWA C600; no leakage will be allowed at joints made by any other method. Test PVC plastic water mains and water service lines made with PVC plastic water main pipe in accordance with the requirements of UBPPA UNI-B-3 for pressure and leakage tests. The amount of leakage on pipelines made of PVC plastic water main pipe shall not exceed the amounts given in UBPPA UNI-B-3, except that at joints made with sleeve-type mechanical couplings, no leakage will be allowed. Test water service lines in accordance with applicable requirements of AWWA C600 for hydrostatic testing. No leakage will be allowed at plastic pipe joints, flanged joints and screwed joints.

### 3.2.3 Special Testing Requirements

For pressure test, use a hydrostatic pressure 50 psi greater than the maximum working pressure of the system, except that for those portions of the system having pipe size larger than 2 inches in diameter, hydrostatic test pressure shall be not less than 200 psi. Hold this pressure for not less than 2 hours. Prior to the pressure test, fill that portion of the pipeline being tested with water for a soaking period of not less than 24 hours. For leakage test, use a hydrostatic pressure not less than the maximum working pressure of the system. Leakage test may be performed at the same time and at the same test pressure as the pressure test.

## 3.3 CLEANUP

Upon completion of the installation of water lines, and appurtenances, all debris and surplus materials resulting from the work shall be removed.

-- End of Section 33 11 00 --

SECTION 33 30 00
SANITARY SEWERS

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN WATER WORKS ASSOCIATION (AWWA)

| | |
|---|---|
| AWWA C104/A21.4 | (2013) Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water |
| AWWA C110/A21.10 | (2012) Ductile-Iron and Gray-Iron Fittings for Water |
| AWWA C111/A21.11 | (2012) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM C969 | (2002; R 2009) Standard Practice for Infiltration and Exfiltration Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines |
| ASTM D1784 | (2011) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds |
| ASTM D2321 | (2011) Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications |
| ASTM D2680 | (2001; R 2009) Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Composite Sewer Piping |
| ASTM D3034 | (2014) Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings |
| ASTM D3139 | (1998; R 2011) Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals |
| ASTM D3212 | (2007; R 2013) Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals |

| | |
|---|---|
| ASTM F477 | (2010) Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe |
| ASTM F949 | (2010) Poly(Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings |

UNI-BELL PVC PIPE ASSOCIATION (UBPPA)

| | |
|---|---|
| UBPPA UNI-B-6 | (1998) Recommended Practice for Low-Pressure Air Testing of Installed Sewer Pipe |

## 1.2 SYSTEM DESCRIPTION

### 1.2.1 Sanitary Sewer Gravity Pipeline

Provide laterals lines of polyvinyl chloride (PVC) plastic pipe. Provide new and modify existing exterior sanitary gravity sewer piping and appurtenances. Provide each system complete and ready for operation. The exterior sanitary gravity sewer system includes equipment, materials, installation, and workmanship as specified herein more than 5 feet outside of building walls.

## 1.3 GENERAL REQUIREMENTS

The construction required herein shall include appurtenant structures and building sewers to points of connection with the building drains 5 feet outside the building to which the sewer system is to be connected. The Contractor shall replace damaged material and redo unacceptable work at no additional cost to the Government. Backfilling shall be accomplished after inspection by the Contracting Officer's Representative. Before, during, and after installation, plastic pipe and fittings shall be protected from any environment that would result in damage or deterioration to the material. The Contractor shall have a copy of the manufacturer's instructions available at the construction site at all times and shall follow these instructions unless directed otherwise by the Contracting Officer's Representative. Solvents, solvent compounds, lubricants, elastomeric gaskets, and any similar materials required to install the plastic pipe shall be stored in accordance with the manufacturer's recommendation and shall be discarded if the storage period exceeds the recommended shelf life. Solvents in use shall be discarded when the recommended pot life is exceeded.

## 1.4 SUBMITTALS

Contracting Officer's written approval is required for submittals. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Pipeline materials

Submit manufacturer's standard drawings or catalog cuts.

SD-06 Test Reports

Reports

Test and inspection reports, as specified.

## 1.5 DELIVERY, STORAGE, AND HANDLING

### 1.5.1 Delivery and Storage

#### 1.5.1.1 Piping

Inspect materials delivered to site for damage; store with minimum of handling. Store materials on site in enclosures or under protective coverings. Store plastic piping and jointing materials and rubber gaskets under cover out of direct sunlight. Do not store materials directly on the ground. Keep inside of pipes and fittings free of dirt and debris.

#### 1.5.1.2 Metal Items

Check upon arrival; identify and segregate as to types, functions, and sizes. Store off the ground in a manner affording easy accessibility and not causing excessive rusting or coating with grease or other objectionable materials.

#### 1.5.1.3 Cement, Aggregate, and Reinforcement

As specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

### 1.5.2 Handling

Handle pipe, fittings, and other accessories in such manner as to ensure delivery to the trench in sound undamaged condition. Carry, do not drag, pipe to trench.

## 1.6 INSTALLER QUALIFICATIONS

Install specified materials by a licensed underground utility Contractor licensed for such work in the state where the work is to be performed. Installing Contractor's License shall be current and be state certified or state registered.

# PART 2 PRODUCTS

## 2.1 PIPELINE MATERIALS

Pipe shall conform to the respective specifications and other requirements specified below.

2.1.1 PVC Plastic Gravity Sewer Piping

2.1.1.1 PVC Plastic Gravity Pipe and Fittings

ASTM D3034, SDR 35, or ASTM F949 with ends suitable for elastomeric gasket joints.

2.1.1.2 PVC Plastic Gravity Joints and Jointing Material

Joints shall conform to ASTM D3212. Gaskets shall conform to ASTM F477.

2.1.2 PVC Plastic Pressure Pipe and Associated Fittings

2.1.2.1 PVC Plastic Pressure Pipe and Fittings

a. Pipe and Fittings Less Than 4 inch Diameter: Pipe, couplings and fittings shall be manufactured of materials conforming to ASTM D1784, Class 12454B.

(1) Push-On Joint: ASTM D3139, with ASTM F477 gaskets. Fittings for push-on joints shall be iron conforming to AWWA C110/A21.10 or AWWA C111/A21.11. Iron fittings and specials shall be cement-mortar lined (standard thickness) in accordance with AWWA C104/A21.4.

2.1.2.2 PVC Plastic Pressure Joints and Jointing Material

Joints for pipe, 4 inch to 12 inch diameter, shall be push-on joints as specified in ASTM D3139. Joints between pipe and fittings shall be push-on joints as specified in ASTM D3139 or shall be compression-type joints/mechanical-joints as respectively specified in ASTM D3139 and AWWA C111/A21.11. Each joint connection shall be provided with an elastomeric gasket suitable for the bell or coupling with which it is to be used. Gaskets for push-on joints for pipe shall conform to ASTM F477. Gaskets for push-on joints and compression-type joints/mechanical-joints for joint connections between pipe and fittings shall be as specified in AWWA C111/A21.11, respectively, for push-on joints and mechanical-joints.

2.2 SEPTIC TANK

Septic tanks shall be manufactured from concrete and meet all State and Local requirements for commercial installations including but not limited to the Local Health Department. All products shall meet North Carolina Public Health "Approved On-Site Wastewater Product" requirements.

2.3 REPORTS

Submit Test Reports. Compaction and density test shall be in accordance with Section 31 23 00 EXCAVATION AND FILL.

PART 3 EXECUTION

## 3.1 INSTALLATION OF PIPELINES AND APPURTENANT CONSTRUCTION

### 3.1.1 General Requirements for Installation of Pipelines

These general requirements apply except where specific exception is made in the following paragraphs entitled "Special Requirements."

#### 3.1.1.1 Location

The work covered by this section shall terminate at a point approximately 5 feet from the building. Where possible, do not lay sewer line closer horizontally than 10 feet to a water main or service line. Install pressure sewer lines beneath water lines only, with the top of the sewer line being at least 2 feet below bottom of water line. Where sanitary sewer lines pass above water lines, encase sewer in concrete for a distance of 10 feet on each side of the crossing. Where sanitary sewer lines pass below water lines, lay pipe so that no joint in the sewer line will be closer than 3 feet, horizontal distance, to the water line.

a. Sanitary piping installation parallel with water line:

(1) Normal conditions: Sanitary piping or manholes shall be laid at least 10 feet horizontally from a water line whenever possible. The distance shall be measured edge-to-edge.

(2) Unusual conditions: When local conditions prevent a horizontal separation of 10 feet, the sanitary piping or manhole may be laid closer to a water line provided that:

(a) The top (crown) of the sanitary piping shall be at least 18 inches below the bottom (invert) of the water main.

(b) Where this vertical separation cannot be obtained, the sanitary piping shall be constructed of AWWA-approved ductile iron water pipe pressure tested in place without leakage prior to backfilling.

(c) The sewer manhole shall be of watertight construction and tested in place.

b. Installation of sanitary piping crossing a water line:

(1) Normal conditions: Lay sanitary sewer piping by crossing under water lines to provide a separation of at least 18 inches between the top of the sanitary piping and the bottom of the water line whenever possible.

(2) Unusual conditions: When local conditions prevent a vertical separation described above, use the following construction:

(a) Sanitary piping passing over or under water lines shall be constructed of AWWA-approved ductile iron water pipe, pressure tested in place without leakage prior to backfilling.

(b) Sanitary piping passing over water lines shall, in addition, be protected by providing:

(1) A vertical separation of at least 18 inches between the bottom of the sanitary piping and the top of the water line.

(2) Adequate structural support for the sanitary piping to prevent excessive deflection of the joints and the settling on and breaking of the water line.

(3) That the length, minimum 20 feet, of the sanitary piping be centered at the point of the crossing so that joints shall be equidistant and as far as possible from the water line.

c. Sanitary sewer manholes: No water piping shall pass through or come in contact with any part of a sanitary sewer manhole.

3.1.1.2 Earthwork

Perform earthwork operations in accordance with Section 31 23 00 EXCAVATION AND FILL.

3.1.1.3 Pipe Laying and Jointing

Inspect each pipe and fitting before and after installation; replace those found defective and remove from site. Provide proper facilities for lowering sections of pipe into trenches. Lay nonpressure pipe with the bell ends in the upgrade direction. Adjust spigots in bells to give a uniform space all around. Blocking or wedging between bells and spigots will not be permitted. Replace by one of the proper dimensions, pipe or fittings that do not allow sufficient space for installation of joint material. At the end of each work day, close open ends of pipe temporarily with wood blocks or bulkheads. Provide batterboards not more than 25 feet apart in trenches for checking and ensuring that pipe invert elevations are as indicated. Laser beam method may be used in lieu of batterboards for the same purpose. Branch connections shall be made by use of regular fittings or solvent cemented saddles as approved. Saddles for PVC composite pipe shall conform to Figure 2 of ASTM D2680; and saddles for PVC pipe shall conform to Table 4 of ASTM D3034.

3.1.1.4 Connections to Existing Manhole

Obtain approval from the Contracting Officer’s Representative before making connection to existing manhole. Conduct work so that there is minimum interruption of service on existing line.

3.1.2 Special Requirements

3.1.2.1 Installation of PVC Plastic Piping

Install pipe and fittings in accordance with paragraph entitled "General Requirements for Installation of Pipelines" of this section and with the requirements of ASTM D2321 for laying and joining pipe and fittings. Make joints with the gaskets specified for joints with this piping and assemble in accordance with the requirements of ASTM D2321 for assembly of joints. Make joints to other pipe materials in accordance with the recommendations of the plastic pipe manufacturer.

3.1.2.2 Installation of Septic Tank

The septic tank shall be installed per the manufacturers written requirements and in accordance with the requirements of North Carolina Public Health.

3.2 FIELD QUALITY CONTROL

3.2.1 Field Tests and Inspections

The Contracting Officer's Representative will conduct field inspections and witness field tests specified in this section. The Contractor shall perform field tests and provide labor, equipment, and incidentals required for testing. Be able to produce evidence, when required, that each item of work has been constructed in accordance with the drawings and specifications.

3.2.2 Tests for Nonpressure Lines

Check each straight run of pipeline for gross deficiencies by holding a light in a manhole; it shall show a practically full circle of light through the pipeline when viewed from the adjoining end of line. When pressure piping is used in a nonpressure line for nonpressure use, test this piping as specified for nonpressure pipe.

3.2.2.1 Leakage Tests

Test lines for leakage by either infiltration tests or exfiltration tests, or by low-pressure air tests. Prior to testing for leakage, backfill trench up to at least lower half of pipe. When necessary to prevent pipeline movement during testing, place additional backfill around pipe sufficient to prevent movement, but leaving joints uncovered to permit inspection. When leakage or pressure drop exceeds the allowable amount specified, make satisfactory correction and retest pipeline section in the same manner. Correct visible leaks regardless of leakage test results.

a. Infiltration tests and exfiltration tests: Perform these tests for sewer lines made of the specified materials, not only concrete, in accordance with ASTM C969. Make calculations in accordance with the Appendix to ASTM C969.

b. Low-pressure air tests: Perform tests as follows:

(1) PVC plastic pipelines: Test in accordance with UBPPA UNI-B-6. Allowable pressure drop shall be as given in UBPPA UNI-B-6. Make calculations in accordance with the Appendix to UBPPA UNI-B-6.

-- End of Section 33 30 00 --