

DSSC DLA Repair Building 27  
Columbus, OH

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## SECTION 02 41 00

## DEMOLITION AND DECONSTRUCTION

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## 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 SOCIETY OF SAFETY PROFESSIONALS (ASSP)

ASSP A10.6 (2006) Safety & Health Program Requirements for Demolition Operations - American National Standard for Construction and Demolition Operations

## U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1 (2024) Safety -- Safety and Occupational Health (SOH) Requirements

## U.S. DEFENSE LOGISTICS AGENCY (DLA)

DLA 4145.25 (Jun 2000; Reaffirmed Oct 2010) Storage and Handling of Liquefied and Gaseous Compressed Gases and Their Full and Empty Cylinders;  
<https://www.dla.mil/Portals/104/Documents/DispositionSer/ddsr/docs/cylinderjointpub.pdf>

## U.S. DEPARTMENT OF DEFENSE (DOD)

DOD 4000.25-1-M (2006) MILSTRIP - Military Standard Requisitioning and Issue Procedures

MIL-STD-129 (2014; Rev R; Change 1 2018; Change 2 2019; Change 3 2023) Military Marking for Shipment and Storage

## 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

49 CFR 173.301 Shipment of Compressed Gases in Cylinders

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## and Spherical Pressure Vessels

### 1.2 PROJECT DESCRIPTION

#### 1.2.1 Definitions

##### 1.2.1.1 Demolition

Demolition is the process of tearing apart and removing any feature of a facility together with any related handling and disposal operations.

##### 1.2.1.2 Deconstruction

Deconstruction is the process of taking apart a facility with the primary goal of preserving the value of all useful building materials.

##### 1.2.1.3 Demolition Plan

Demolition Plan is the planned steps and processes for managing demolition activities and identifying the required sequencing activities and disposal mechanisms.

##### 1.2.1.4 Deconstruction Plan

Deconstruction Plan is the planned steps and processes for dismantling all or portions of a structure or assembly, to include managing sequencing activities, storage, re-installation activities, salvage and disposal mechanisms.

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#### 1.2.2 Demolition/Deconstruction Plan

Prepare a Demolition Plan demolition and removal procedures for approval before work is started. Include in the plan procedures for careful removal and disposition of materials specified to be salvaged, coordination with other work in progress, a disconnection schedule of utility services, a detailed description of methods and equipment to be used for each operation and of the sequence of operations. Coordinate with Waste Management Plan in accordance with Section 01 74 19 CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL. Provide procedures for safe conduct of the work in accordance with EM 385-1-1. Plan must be approved by Contracting Officer prior to work beginning.

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#### 1.2.3 General Requirements

Do not begin demolition or deconstruction until authorization is received from the Contracting Officer. Remove rubbish and debris from the project site; do not allow accumulations inside or outside the building. The work includes demolition and deconstruction, 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 17, Demolition, and other applicable Sections.

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### 1.3 ITEMS TO REMAIN IN PLACE

Comply with FAR 52.236-9 to protect existing vegetation, structures, equipment, utilities, and improvements. 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, deconstruction, or demolition work performed under this contract. Do not overload structural elements and pavements to remain. Provide new supports and reinforcement for existing construction weakened by demolition, deconstruction, or removal work. Repairs, reinforcement, or structural replacement require approval by the Contracting Officer 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 dust, dirt, and debris from work areas daily.

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#### 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.

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#### 1.3.3 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 .

#### 1.3.4 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. 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, deconstruction, 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.

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#### 1.5 AVAILABILITY OF WORK AREAS

Areas in which the work is to be accomplished will be available at contract award.

#### 1.6 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

##### SD-01 Preconstruction Submittals

Demolition Plan; G

Deconstruction Plan; G

Existing Conditions

##### SD-07 Certificates

Notification; G

##### SD-11 Closeout Submittals

Receipts

#### 1.7 QUALITY ASSURANCE

Submit timely notification of demolition, deconstruction and renovation projects to Federal, State, regional, and local authorities in accordance with 40 CFR 61, Subpart M. Notify the local air pollution control district/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 ASSP A10.6. Comply with the Environmental Protection Agency requirements specified. Use of explosives will not be permitted.

##### 1.7.1 Dust and Debris Control

Prevent the spread of dust and debris to occupied portions of the building 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. Vacuum and dust the work area daily.

#### 1.8 PROTECTION

##### 1.8.1 Traffic Control Signs

a. Where pedestrian and driver safety is endangered in the area of removal work, use traffic barricades with flashing lights. Anchor barricades in a manner to prevent displacement by wind. Notify the Contracting Officer prior to beginning such work.

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### 1.8.2 Protection of Personnel

Before, during and after the demolition and deconstruction work continuously evaluate the condition of the site specific features structure being demolished and deconstructed 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.

### 1.9 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.

### 1.10 EXISTING CONDITIONS

Before beginning any demolition or deconstruction 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 or the Contracting Officer's Representative showing the condition of structures and other facilities adjacent to areas of alteration or removal. Photographs or electronic images with a minimum resolution of 3072 x 2304 pixels, capable of a print resolution of 300 dpi, 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 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 to the Contracting Officer or the Contracting Officer's Representative.

## 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.

## PART 3 EXECUTION

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### 3.1 EXISTING FACILITIES TO BE REMOVED

**DELETED**

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### 3.1.1 Structures

- a. Remove existing structures indicated to be removed to as indicated in the drawings. Remove interior walls, other than retaining walls and partitions, to 0 feet below grade or to top of concrete slab on ground.
- b. Demolish and Deconstruct 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.
- c. Locate demolition and deconstruction 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. 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.

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### 3.1.3 Masonry

Sawcut and remove masonry so as to prevent damage to surfaces to remain and to facilitate the installation of new work. Where new masonry adjoins existing, abut or tie the new work into the existing construction as indicated and specified for the new work. Provide square, straight edges and corners where existing masonry adjoins new work and other locations.

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### 3.1.4 Concrete

Saw concrete along straight lines to a depth of a minimum 2 inch. Make each cut in walls perpendicular to the face and in alignment with the cut in the opposite face. Break out the remainder of the concrete provided that the broken area is concealed in the finished work, and the remaining concrete is sound. At locations where the broken face cannot be concealed, grind smooth or saw cut entirely through the concrete. Sawcuts in existing concrete sidewalk concrete pads parking areas must be at the nearest existing expansion joint or weakened plane joint and at full depth.

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### 3.1.5 Miscellaneous Metal

Scrap metal is the Contractor's property. Recycle scrap metal as part of demolition and deconstruction operations. Provide separate containers to

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collect scrap metal and transport to a scrap metal collection or recycling facility, in accordance with the Waste Management Plan.

### 3.1.6 Carpentry

#### **DELETED**

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### 3.1.7 Acoustic Ceiling Tile

Remove, neatly stack, and recycle acoustic ceiling tiles. Recycling may be available with manufacturer. Otherwise, give priority to a local recycling organization. Recycling is not required if the tiles contain or may have been exposed to asbestos material.

### 3.1.8 Patching

Where removals leave holes and damaged surfaces exposed in the finished work, patch and repair these holes and damaged surfaces to match adjacent finished surfaces, using on-site materials when available. Where new work is to be applied to existing surfaces, perform removals and patching in a manner to produce surfaces suitable for receiving new work. Make finished surfaces of patched area flush with the adjacent existing surface and match the existing adjacent surface as closely as possible to texture and finish. Provide patching as specified and indicated, and include the following:

- a. Concrete and Masonry: Completely fill holes and depressions, caused by previous physical damage or left as a result of removals in existing masonry walls to remain, with an approved masonry patching material, applied in accordance with the manufacturer's printed instructions.
- b. Where existing partitions have been removed leaving damaged or missing resilient tile flooring, patch to match the existing floor tile.
- c. Patch acoustic lay-in ceiling where partitions have been removed. Make the transition between the different ceiling heights by continuing the higher ceiling level over to the first runner on the lower ceiling and closing the vertical opening with a painted sheet metal strip.

### 3.1.9 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)." Turn in salvaged Class I ODS refrigerants as specified in paragraph, "Salvaged Materials and Equipment."

### 3.1.10 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)."

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#### 3.1.11 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 after removal.

#### 3.1.12 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. Salvage each item of equipment and fixtures as a whole unit; listed, indexed, tagged, and stored. Salvage each unit with its normal operating auxiliary equipment. Transport salvaged equipment and fixtures, including motors and machines, to a designated on station storage area as directed by the Contracting Officer. Do not remove equipment until approved. Do not offer low-efficiency equipment for reuse; provide to recycling service for disassembly and recycling of parts.

##### 3.1.12.1 Preparation for Storage

Remove water, dirt, dust, and foreign matter from units; drain tanks, piping and fixtures; if previously used to store flammable, explosive, or other dangerous liquids, steam clean interiors. Seal openings with caps, plates, or plugs. Secure motors attached by flexible connections to the unit. Change lubricating systems with the proper oil or grease.

##### 3.1.12.2 Piping

Disconnect piping at unions, flanges and valves, and fittings as required to reduce the pipe into straight lengths for practical storage. Store salvaged piping according to size and type. If the piping that remains can become pressurized due to upstream valve failure, attach end caps, blind flanges, or other types of plugs or fittings with a pressure gage and bleed valve to the open end of the pipe to ensure positive leak control. Carefully dismantle piping that previously contained gas, gasoline, oil, or other dangerous fluids, with precautions taken to prevent injury to persons and property. Store piping outdoors until all fumes and residues are removed. Box prefabricated supports, hangers, plates, valves, and specialty items according to size and type. Wrap sprinkler heads individually in plastic bags before boxing. Classify piping not designated for salvage, or not reusable, as scrap metal.

##### 3.1.12.3 Ducts

Classify removed duct work as scrap metal.

##### 3.1.12.4 Fixtures, Motors and Machines

Remove and salvage fixtures, motors and machines associated with plumbing, heating, air conditioning, refrigeration, and other mechanical system installations. Salvage, box and store auxiliary units and accessories with the main motor and machines. Tag salvaged items for identification, storage, and protection from damage. Classify broken, damaged, or otherwise unserviceable units and not caused to be broken, damaged, or otherwise unserviceable as debris to be disposed of by the Contractor.

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### 3.1.13 Electrical Equipment and Fixtures

Salvage motors, motor controllers, and operating and control equipment that are attached to the driven equipment. Salvage wiring systems and components. Box loose items and tag for identification. Disconnect primary, secondary, control, communication, and signal circuits at the point of attachment to their distribution system.

#### 3.1.13.1 Fixtures

Remove and salvage electrical fixtures. Salvage unprotected glassware from the fixture and salvage separately. Salvage incandescent, mercury-vapor, and fluorescent lamps and fluorescent ballasts manufactured prior to 1978, boxed and tagged for identification, and protected from breakage.

#### 3.1.13.2 Electrical Devices

Remove and salvage switches, switchgear, transformers, conductors including wire and nonmetallic sheathed and flexible armored cable, regulators, meters, instruments, plates, circuit breakers, panelboards, outlet boxes, and similar items. Box and tag these items for identification according to type and size.

#### 3.1.13.3 Wiring Ducts or Troughs

Remove and salvage wiring ducts or troughs. Dismantle plug-in ducts and wiring troughs into unit lengths. Remove plug-in or disconnecting devices from the busway and store separately.

#### 3.1.13.4 Conduit and Miscellaneous Items

Salvage conduit except where embedded in concrete or masonry. Consider corroded, bent, or damaged conduit as scrap metal. Sort straight and undamaged lengths of conduit according to size and type. Classify supports, knobs, tubes, cleats, and straps as debris to be removed and disposed.

#### 3.1.14 Elevators and Hoists

Remove elevators, hoists, and similar conveying equipment and salvage as whole units, to the most practical extent. Remove and prepare items for salvage without damage to any of the various parts. Salvage and store rails for structural steel with the equipment as an integral part of the unit.

### 3.2 CONCURRENT EARTH-MOVING OPERATIONS

Do not begin excavation, filling, and other earth-moving operations that are sequential to demolition or deconstruction work in areas occupied by structures to be demolished or deconstructed until all demolition and deconstruction 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

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not reused or salvaged, become the property of the Contractor and must be removed from Government property. Materials approved for storage by the Contracting Officer must be removed before completion of the contract. Title to materials resulting from demolition and deconstruction, and materials and equipment to be removed, is vested in the Contractor upon approval by the Contracting Officer. 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 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 must be Turn over recovered ODS to the Contracting Officer. Dispose products, equipment and appliances containing ODS in a sealed, self-contained system (e.g. residential refrigerators and window air conditioners) in accordance with 40 CFR 82. Submit Receipts or bills of lading, as specified. Submit a shipping receipt or bill of lading for all containers of ozone depleting substance (ODS) shipped to the Defense Depot, Richmond, Virginia.

#### 3.3.2.1 Special Instructions

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

- 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).

#### 3.3.2.2 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.

### 3.3.3 Transportation Guidance

Ship all ODS containers in accordance with MIL-STD-129, DLA 4145.25 (also referenced one of the following: Army Regulation 700-68, Naval Supply Instruction 4440.128C, Marine Corps Order 10330.2C, and Air Force Regulation 67-12), 49 CFR 173.301, and DOD 4000.25-1-M.

#### 3.3.4 Unsalvageable and Non-Recyclable Material

Dispose of unsalvageable and non-recyclable combustible material off the

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site .

### 3.4 CLEANUP

Remove debris and rubbish from project site 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 in the Waste Management Plan . Storage of removed materials on the project site is prohibited.

#### 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 to Spoil Areas on Government Property

Transport noncombustible materials removed from demolition and deconstruction structures to designated spoil areas on Government property.

#### 3.5.4 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 per Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS.

### 3.6 REUSE OF SALVAGED ITEMS

Recondition salvaged materials and equipment designated for reuse before installation. Replace items damaged during removal and salvage operations or restore them as necessary to usable condition.

-- End of Section --

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SECTION 05 52 00

METAL RAILINGS

08/23

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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 (2017) Steel Construction Manual
- AISC 326 (2009) Detailing for Steel Construction

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

- ASCE 7-22 (2022; Supp 1 2023; Supp 2 2023; Supp 3 2025) Minimum Design Loads and Associated Criteria for Buildings and Other Structures

AMERICAN WELDING SOCIETY (AWS)

- AWS A2.4 (2012) Standard Symbols for Welding, Brazing and Nondestructive Examination
- AWS D1.1/D1.1M (2025) Structural Welding Code - Steel

1.2 ADMINISTRATIVE REQUIREMENTS

1.2.1 Preinstallation Meetings

Within 30 days of contract award, submit fabrication drawings to the Contracting Officer for the following items:

- a. Steel railings and handrails
- b. Anchorage and fastening systems

Submit manufacturer's catalog data, including two copies of manufacturers specifications, load tables, dimension diagrams, and anchor details for the following items:

- a. Steel railings and handrails
- b. Anchorage and fastening systems

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1.3 SUBMITTALS

Government approval is required for submittals with a "G" or "S"

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classification. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fabrication Drawings; G,  
Iron and Steel Hardware; G,  
Steel Shapes, Plates, Bars and Strips; G,

SD-03 Product Data

Concrete Inserts; G,  
Masonry Anchorage Devices; G,  
Protective Coating; G,  
Steel Railings and Handrails; G,  
Anchorage and Fastening Systems; G,

SD-05 Design Data

Design Calculations For Steel Connections; G

SD-06 Test Reports

Welding Inspections; G  
Mill Test Reports; G

SD-07 Certificates

Welder Qualification; G,

SD-08 Manufacturer's Instructions

Installation Instructions

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1.4 QUALITY CONTROL

1.4.1 Welding Procedures

Section 05 05 23.16 STRUCTURAL WELDING applies to work specified in this section.

Submit results of welding inspections testing in accordance with AWS D1.1/D1.1M by an approved testing laboratory at the Contractor's expense. Provide laboratory welding inspection results to Contracting Officer.

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#### 1.4.2 Welder Qualification

Submit certified welder qualification by tests in accordance with AWS D1.1/D1.1M, or under an equivalent approved qualification test. In addition, perform tests on test pieces in positions and with clearances equivalent to those actually encountered. If a test weld fails to meet requirements, conduct an immediate retest of two test welds and ensure that 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.

#### 1.5 QUALITY ASSURANCE

##### 1.5.1 Fabrication Drawing Requirements

Submit fabrication drawings for approval prior to fabrication. Prepare in accordance with AISC 325, AISC 326, ASCE 7-22, and State of OH Building Code. Fabrication drawings will not be reproductions of contract drawings. 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. Clearly highlight any deviations from the details shown on the contract drawings highlighted on the fabrication drawings. Explain the reasons for any deviations from the contract drawings.

### PART 2 PRODUCTS

#### 2.1 FABRICATION

Preassemble 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, before cleaning, treating, and applying surface finishes, including zinc coatings.

Provide railing and handrail 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 the size and thickness necessary to produce adequate strength and durability in the finished product for its intended use. Work the materials to the dimensions indicated on approved detail drawings, using proven details of fabrication and support. Use the 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 that 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.

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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 the 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 countersunk Phillips flathead 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.

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2.1.1 Aluminum Railings

**DELETED**

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2.1.2 Steel Handrails

Fabricate joint posts, rail, and corners by one of the following methods:

- a. Flush-type rail fittings of commercial standard, welded and ground smooth, with railing splice locks secured with 3/8 inch hexagonal-recessed-head setscrews.
- b. 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.
- c. Railings may be bent at corners in lieu of jointing, provided that bends are made in suitable jigs and the pipe is not crushed.

2.1.3 Protective Coating

Shop-prime the steelwork as indicated in accordance with Section 09 90 00 PAINTS AND COATINGS except the following:

- a. Steel surfaces encased in concrete
- b. Steel surfaces for welding
- c. High-strength bolt-connected contact surfaces
- d. Crane rail surfaces

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## 2.2 COMPONENTS

## 2.3 Mill Test Reports

Provide mill test reports for . Mill test report will include but is not limited to material heat number, material grade, edition year and type of specification met, material dimension, mechanical properties, chemical analysis, heat treatment (if applicable), and certified inspector signature.

# PART 3 EXECUTION

## 3.1 PREPARATION

Adjust stair railings and handrails before securing in place in order to ensure proper matching at butting joints and correct alignment throughout their length. Space posts not more than 8 feet on center. Plumb posts in each direction. Secure posts and rail ends to building construction as follows:

- a. 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 the post and sleeve with nonshrink grout or a quick-setting hydraulic cement. Cover anchorage joint with a round steel flange welded to the post.

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 finished 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:

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

## 3.2 INSTALLATION

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. Masonry anchorage devices
- c. Steel railings and handrails

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d. 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 cited in this section.

3.2.1 Steel Handrail

Install handrail by means of masonry with expansion shields and bolts or toggle bolts. Secure rail ends by steel pipe flanges anchored by expansion shields and bolts.

3.2.2 Touchup Painting

Immediately after installation, clean field welds, bolted connections, abraded areas of the shop paint, and exposed areas painted with the paint used for shop painting. Apply paint by brush or spray to provide a minimum dry-film thickness of 2 mils.

3.3 FIELD QUALITY CONTROL

3.3.1 Field Welding

Ensure that 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 --

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## SECTION 07 60 00

## FLASHING AND SHEET METAL

**08/23****Amendment 0003**

## 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; Errata 1 2014; Errata 2 2020)  
Structural Welding Code - Aluminum

## ASTM INTERNATIONAL (ASTM)

|                 |                                                                                                                                         |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------|
| ASTM A308/A308M | (2010) Standard Specification for Steel Sheet, Terne (Lead-Tin Alloy) Coated by the Hot Dip Process                                     |
| ASTM A480/A480M | (2024) Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip       |
| ASTM A653/A653M | (2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process |
| ASTM A792/A792M | (2022) Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process                                    |
| ASTM B69        | (2021) Standard Specification for Rolled Zinc                                                                                           |
| ASTM B101       | (2022) Standard Specification for Lead-Coated Copper Sheet and Strip for Building Construction                                          |
| ASTM B209/B209M | (2021a) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate                                                          |
| ASTM B370       | (2022) Standard Specification for Copper Sheet and Strip for Building Construction                                                      |
| ASTM D2244      | (2021) Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates       |

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ASTM D4214 (2007; R 2015) Standard Test Method for  
Evaluating the Degree of Chalking of  
Exterior Paint Films

ASTM E2112 (2023) Standard Practice for Installation  
of Exterior Windows, Doors and Skylights

#### NATIONAL ROOFING CONTRACTORS ASSOCIATION (NRCA)

NRCA 0429 (2022) The NRCA Roofing Manual:  
Architectural Metal Flashing, Condensation  
and Air Leakage Control and Reroofing

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

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

### 1.2 GENERAL REQUIREMENTS

Finished sheet metal assemblies must form a weathertight enclosure without waves, warps, buckles, fastening stresses or distortion, while allowing for expansion and contraction without damage to the system. The sheet metal installer is responsible for cutting, fitting, drilling, and other operations in connection with sheet metal modifications 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, uninterrupted roofing operations.

#### 1.2.1 General Material Requirements

All materials specified in this Section installed in conjunction with the roofing system must be provided by the roofing system manufacturer, or by a manufacturer approved by the roofing system manufacturer for use in the roofing system, and must form a part of the Warranty as required by the applicable roofing system Section.

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### 1.3 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Exposed Sheet Metal Coverings;

Downspouts;

SD-04 Samples

Finish Samples;

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#### SD-07 Certificates

Warranty on Finishes;

#### SD-08 Manufacturer's Instructions

Instructions for Installation;

#### SD-10 Operation and Maintenance Data

Cleaning and Maintenance;

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### 1.4 MISCELLANEOUS REQUIREMENTS

#### 1.4.1 Product Data

Indicate thicknesses, dimensions, fastenings, 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.

#### 1.4.2 Finish Samples

Submit two color charts and two finish sample chips from manufacturer's standard color and finish options for each type of finish indicated.

#### 1.4.3 Operation and Maintenance Data

Submit detailed instructions for installation and quality control during installation, cleaning and maintenance, for each type of assembly indicated.

### 1.5 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 installation.

## PART 2 PRODUCTS

### 2.1 RECYCLED CONTENT

Provide products with recycled content. Provide data for each product with recycled content, identifying percentage of recycled content.

### 2.2 MATERIALS

Use any metal listed by NRCA 0429 or SMACNA 1793 for a particular item, unless otherwise indicated. Provide materials and configurations in accordance with NRCA 0429 or SMACNA 1793 for each material, while also meeting the minimum thickness requirements specified in this Section. Different items need not be of the same metal, except that contact between dissimilar metals must be avoided.

Provide sheet metal items in 8 to 10 foot lengths. Single pieces less than

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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:

#### 2.2.1 Exposed Sheet Metal Items

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

#### 2.2.2 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.

#### 2.2.3 Copper, Sheet and Strip

Provide in accordance with ASTM B370, cold-rolled temper, H 00 (standard).

#### 2.2.4 Lead-Coated Copper Sheet

Provide in accordance with ASTM B101.

#### 2.2.5 Lead Sheet

Provide in a minimum weight of 4 pounds per square foot.

#### 2.2.6 Steel Sheet, Zinc-Coated (Galvanized)

Provide in accordance with ASTM A653/A653M, a minimum of 24 gauge, and a minimum zinc coat weighting of 90 ounces per square feet.

#### 2.2.7 Zinc Sheet and Strip

Provide in accordance with ASTM B69, Type I, a minimum of 0.024 inch thick.

#### 2.2.8 Steel Sheet, Aluminum Zinc-Coated

Provide in accordance with ASTM A792/A792M, a minimum of 24 gauge.

#### 2.2.9 Stainless Steel

Provide in accordance with ASTM A480/A480M, Type 302 or 304, 2D Finish, fully annealed, dead-soft temper, a minimum of 24 gauge.

#### 2.2.10 Terne-Coated Steel

Provide in accordance with ASTM A308/A308M, a minimum of 14 by 20 inch with minimum of 40 pound coating per double base box. ASTM A308/A308M.

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#### 2.2.11 Aluminum Alloy Sheet and Plate

Provide in accordance with ASTM B209/B209M anodized color to match existing form alloy, and temper appropriate for use. Provide material not less than 0.065-in in thickness.

#### 2.2.12 Finishes

Provide exposed exterior sheet metal and aluminum with a baked on, factory applied coil fluoropolymer color coating or approved equal siliconized polyester coating. Dry film thickness of coatings must be 0.8 to 1.3 mils. Color to be selected from as indicated on the Drawings. Field applications of color coatings are prohibited and will be rejected.

##### 2.2.12.1 Warranty on Finishes

Provide a manufacturer's warranty to repair, or replace, sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within 20 years from date of project substantial completion. Deterioration includes the following:

- a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
- b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
- c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

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#### 2.2.13 Cool Roof Finishes

**DELETED**

#### 2.2.14 Aluminum Alloy, Extruded Bars, Rods, Shapes, and Tubes

**DELETED**

#### 2.2.15 Solder

**DELETED**

#### 2.2.16 Reglets

**DELETED**

##### 2.2.16.1 Polyvinyl Chloride Reglets

**DELETED**

##### 2.2.16.2 Metal Reglets

**DELETED**

##### 2.2.16.2.1 Caulked Reglets

**DELETED**

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#### 2.2.16.2.2 Friction Reglets

**DELETED**

#### 2.2.17 Scuppers

**DELETED**

#### 2.2.18 Conductor Heads

**DELETED**

#### 2.2.19 Splash Pans

**DELETED**

#### 2.2.20 Copings

**DELETED**

#### 2.2.21 Bituminous Plastic Cement

**DELETED**

#### 2.2.22 Roofing Felt

**DELETED**

#### 2.2.23 Asphalt Primer

**DELETED**

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#### 2.2.24 Fasteners

Use the same metal as, or a metal compatible with the item fastened. Confirm compatibility of fasteners and items to be fastened to avoid galvanic corrosion due to 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

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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 inches. 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 is not 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 inches and over in width. Space cleats evenly not over 12 inches on center unless otherwise specified or indicated. Unless otherwise specified, provide cleats of 2 inches wide by 3 inches 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. Pre-tin 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 inches 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 Lap Seams

Finish soldered seams not less than one inch wide. Overlap seams not soldered, not less than 3 inches.

#### 3.1.5.3 Loose-Lock Expansion Seams

Not less than 3 inches wide; provide minimum one inch movement within the joint. Completely fill the joints with the specified sealant, applied at not less than 1/8 inch thick bed.

#### 3.1.5.4 Standing Seams

Not less than one inch high, double locked without solder.

#### 3.1.5.5 Flat Seams

Make seams in the direction of the flow.

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### 3.1.6 Soldering

Where soldering is specified, apply to copper, terne-coated stainless steel, zinc-coated steel, and stainless steel items. Pre-tin edges of sheet metal before soldering is begun. 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

Scrape or wire-brush the edges of lead-coated material to be soldered to produce a bright surface. Flux brush the seams in before soldering. Treat with soldering acid flux the edges of stainless steel to be pre-tinned. 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 inches maximum on center. Where end lap fasteners are required to improve closure, locate the end lap fasteners not more than 2 inches from the end of the overlapping sheet.

### 3.1.8 Protection from Contact with Dissimilar Materials

#### 3.1.8.1 Copper or Copper-bearing Alloys

Paint with heavy-bodied bituminous paint surfaces in contact with dissimilar metal, or separate the surfaces by means of moistureproof building felts.

#### 3.1.8.2 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.

#### 3.1.8.3 Metal Surfaces

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

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#### 3.1.8.4 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 and at not more than 40 foot intervals for other metals. 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 gravel stops and fascia by expansion and contraction joints spaced not more than 12 feet apart.

### **Amendment 0003\*\*\*\*\***

#### 3.1.10 Base Flashing

**DELETED**

#### 3.1.11 Counterflashing

**DELETED**

#### 3.1.12 Metal Reglets

**DELETED**

##### 3.1.12.1 Caulked Reglets

**DELETED**

##### 3.1.12.2 Friction Reglets

**DELETED**

#### 3.1.13 Polyvinyl Chloride Reglets for Temporary Construction

**DELETED**

#### 3.1.14 Gutters

**DELETED**

### **\*\*\*\*\*Amendment 0003**

#### 3.1.15 Downspouts

Space supports for downspouts according to the manufacturer's recommendation for the masonry or steel substrate. Types, shapes and sizes are indicated. Provide complete including elbows and offsets. Provide downspouts in approximately 10 foot lengths. Provide end joints to telescope not less than 1/2 inch and lock longitudinal joints. Provide gutter outlets with wire ball strainers for each outlet. Provide strainers to fit tightly into outlets and be of the same material used for gutters. Keep downspouts not less than one inch away from walls. Fasten to the walls at top, bottom, and at an intermediate point not to exceed 5 feet on center with leader straps or concealed rack-and-pin type fasteners. Form

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straps and fasteners of metal compatible with the downspouts.

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3.1.15.1 Terminations

**DELETED**

3.1.16 Flashing for Roof Drains

**DELETED**

3.1.17 Scuppers

**DELETED**

3.1.18 Conductor Heads

**DELETED**

3.1.19 Splash Pans

**DELETED**

**\*\*\*\*\*Amendment 0003**

3.1.20 Flashing at Wall Openings

Install pan flashing in the rough opening sill at all penetrations in the exterior wall assemblies, such as windows, louvers, storefronts and curtain walls. Pan sill flashing must have end dams at both jambs a minimum of 2 in high and a rear dam of 2 in high. Flashing must comply with ASTM E2112 and SMACNA 1793.

3.1.21 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 inches. 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.

3.1.22 Expansion Joints

Provide expansion joints for roofs, walls, and floors as indicated. Provide expansion joints in continuous sheet metal at 40 foot intervals for copper and stainless steel and at 32 foot intervals for aluminum, aluminum gravel stops and fascia which must have expansion joints at not more than 12 foot spacing. Provide evenly spaced joints. 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 spacing. Conform to the requirements of Table I.

3.1.22.1 Floor and Wall Expansion Joints

Provide U-shape with extended flanges for expansion joints in concrete and masonry walls and in floor slabs.

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### 3.1.23 Through Wall Flashing

Provide through wall flashing as required in the applicable wall system Sections.

## 3.2 PAINTING

Touch ups in the field may be applied only after metal substrates have been cleaned and pretreated in accordance with manufacturer's written instructions and products.

Field-paint dissimilar sheet metals in contact to separate and deter galvanic interactions.

### 3.2.1 Aluminum Surfaces

Clean with solvent and apply 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

Establish and maintain a Quality Control Plan for sheet metal used in conjunction with roofing to assure compliance of the installed sheet metalwork with the Contract requirements. Remove work that is not in compliance with the Contract and replace or correct. Include quality control, but not be limited to, the following:

- a. Observation of environmental conditions; number and skill level of sheet metal workers; condition of substrate.
- b. Verification that specified material is provided and installed.
- c. Inspection of sheet metalwork, for proper size(s) and thickness(es), fastening and joining, and proper installation.

### 3.5.1 Procedure

Submit for approval prior to start of roofing work. Include a checklist of points to be observed. Document the actual quality control observations and inspections. Provide a copy of the documentation to the Contracting Officer at the end of each day.

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| TABLE I. SHEET METAL WEIGHTS, THICKNESSES, AND GAGES |            |                          |               |      |                                   |
|------------------------------------------------------|------------|--------------------------|---------------|------|-----------------------------------|
| Sheet Metal Items                                    |            | Aluminum, inch           |               |      | Zinc-Coated Steel, U.S. Std. Gage |
|                                                      | 16         | .032                     | .015          | .015 | 24                                |
|                                                      | 16         | –                        | .015          | .015 | –                                 |
|                                                      | 20         | .040                     | .018          | .018 | –                                 |
| Downspouts and leaders                               | 16         | .032                     | .015          | .015 | 24                                |
| Downspout clips and anchors                          | –          | .040 clip<br>.125 anchor | –             | –    | –                                 |
| Downspout straps, 2-inch                             | 48 (a)     | .060                     | .050          | –    | –                                 |
| Conductor heads                                      | 16         | .032                     | .015          | .015 | –                                 |
| Scupper lining                                       | 20         | .032                     | .015          | .015 | –                                 |
| Strainers, wire diameter or gage                     | No. 9 gage | .144 diameter            | .109 diameter | –    |                                   |
| Flashings:                                           |            |                          |               |      |                                   |
|                                                      | 20         | .040                     | .018          | .018 | 24                                |
| Cap (Counter-flashing)                               | 16         | .032                     | .015          | .015 | 26                                |
|                                                      | 16         | –                        | .015          | .015 | 24                                |
|                                                      | 10         | –                        | .010          | .010 | –                                 |
|                                                      | 16         | –                        | .015          | .015 | –                                 |
|                                                      | 16         | .032                     | .015          | .015 | –                                 |
|                                                      | 16         | .032                     | .015          | .015 | –                                 |
|                                                      | 16 (b)     |                          |               |      |                                   |
| Pipe vent sleeve (d)                                 |            |                          |               |      |                                   |
|                                                      | 16         | –                        | –             | –    | –                                 |
|                                                      |            |                          |               |      |                                   |

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| TABLE I. SHEET METAL WEIGHTS, THICKNESSES, AND GAGES                                                                                                |                        |                         |                |      |                                   |
|-----------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|-------------------------|----------------|------|-----------------------------------|
| Sheet Metal Items                                                                                                                                   |                        | Aluminum, inch          |                |      | Zinc-Coated Steel, U.S. Std. Gage |
|                                                                                                                                                     | -                      | .075                    | -              | -    | -                                 |
|                                                                                                                                                     | 16                     | .032                    | .015           | .015 | -                                 |
|                                                                                                                                                     | 20                     | .050                    | .018           | .018 | 24                                |
|                                                                                                                                                     | 24                     | .050                    | .025           | -    | -                                 |
| Gutters:                                                                                                                                            |                        |                         |                |      |                                   |
| Gutter section                                                                                                                                      | 16                     | .032                    | .015           | .015 | 24                                |
| Continuous cleat                                                                                                                                    | 16                     | .032                    | .015           | .015 | 24                                |
| Hangers, dimensions                                                                                                                                 | 1 inch by 1/8 inch (a) | 1 inch by .080 inch (c) | 1 inch by inch | -    | -                                 |
|                                                                                                                                                     | 16                     | .032                    | .015           | .015 | 24                                |
|                                                                                                                                                     | 10                     | -                       | .010           | .010 | -                                 |
|                                                                                                                                                     | 16                     | .040                    | .018           | .018 | -                                 |
| (a) Brass.                                                                                                                                          |                        |                         |                |      |                                   |
| (b) May be lead weighing 4 pounds per square foot.                                                                                                  |                        |                         |                |      |                                   |
| (c) May be polyvinyl chloride.                                                                                                                      |                        |                         |                |      |                                   |
| (d) 2.5 pound minimum lead sleeve with 4 inch flange. Where lead sleeve is impractical, refer to paragraph SINGLE PIPE VENTS for optional material. |                        |                         |                |      |                                   |

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| TABLE II. SHEET METAL JOINTS                                             |                                                                                                       |                                                                                                              |                                                                                                                                                                                |
|--------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| TYPE OF JOINT                                                            |                                                                                                       |                                                                                                              |                                                                                                                                                                                |
| Item Designation                                                         | Copper,<br>Terne-Coated<br>Stainless Steel,<br>Zinc-Coated Steel<br>and Stainless Steel               | Aluminum                                                                                                     | Remarks                                                                                                                                                                        |
| Joint cap for<br>building<br>expansion seam,<br>cleated joint<br>at roof | 1.25 inch single<br>lock, standing<br>seam, cleated                                                   | 1.25 inch single<br>lock, standing                                                                           | --                                                                                                                                                                             |
| Flashings                                                                |                                                                                                       |                                                                                                              |                                                                                                                                                                                |
| Base                                                                     | One inch<br>3 inch lap for<br>expansion joint                                                         | One inch flat<br>locked, soldered;<br>sealed; 3 inch<br>lap for<br>expansion joint                           | Aluminum<br>manufacturer's<br>recommended hard<br>setting sealant<br>for locked<br>aluminum joints.<br>Fill each metal<br>expansion joint<br>with a joint<br>sealing compound. |
| Cap-in reglet                                                            | 3 inch lap                                                                                            | 3 inch lap                                                                                                   | Seal groove with<br>joint sealing<br>compound.                                                                                                                                 |
| Reglets                                                                  | Butt joint                                                                                            | --                                                                                                           | Seal reglet<br>groove with joint<br>sealing compound.                                                                                                                          |
| Eave                                                                     | One inch flat<br>locked, cleated.<br>One inch loose<br>locked, sealed<br>expansion joint,<br>cleated. | One inch flat<br>locked, locked,<br>cleated one inch<br>loose locked,<br>sealed expansion<br>joints, cleated | Same as base<br>flashing.                                                                                                                                                      |
| Stepped                                                                  | 3 inch lap                                                                                            | 3 inch lap                                                                                                   | --                                                                                                                                                                             |
| Valley                                                                   | 6 inch lap cleated                                                                                    | 6 inch lap<br>cleated                                                                                        | --                                                                                                                                                                             |
| Edge strip                                                               | Butt                                                                                                  | Butt                                                                                                         | --                                                                                                                                                                             |
| Gravel stops:                                                            |                                                                                                       |                                                                                                              |                                                                                                                                                                                |
| Extrusions                                                               | --                                                                                                    | Butt with 1/2<br>inch space                                                                                  | Use sheet<br>flashing beneath<br>and a cover plate                                                                                                                             |

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| TABLE II. SHEET METAL JOINTS                                                           |                                                                                         |                                               |                                                                                                |
|----------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|-----------------------------------------------|------------------------------------------------------------------------------------------------|
| TYPE OF JOINT                                                                          |                                                                                         |                                               |                                                                                                |
| Item Designation                                                                       | Copper,<br>Terne-Coated<br>Stainless Steel,<br>Zinc-Coated Steel<br>and Stainless Steel | Aluminum                                      | Remarks                                                                                        |
| Sheet, smooth                                                                          | Butt with 1/4 inch<br>space                                                             | Butt with 1/4<br>inch space                   | Use sheet<br>flashing backup<br>plate.                                                         |
| Sheet,<br>corrugated                                                                   | Butt with 1/4 inch<br>space                                                             | Butt with 1/4<br>inch space                   | Use sheet<br>flashing beneath<br>and a cover plate<br>or a combination<br>unit                 |
| Gutters                                                                                | 1.5 inch lap,<br>riveted and<br>soldered                                                | One inch flat<br>locked riveted<br>and sealed | Aluminum<br>producers<br>recommended hard<br>setting sealant<br>for locked<br>aluminum joints. |
| (a) Provide a 3 inch lap elastomeric flashing with manufacturer's recommended sealant. |                                                                                         |                                               |                                                                                                |
| (b) Seal Polyvinyl chloride reglet with manufacturer's recommended sealant.            |                                                                                         |                                               |                                                                                                |

-- End of Section --

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## SECTION 08 51 13

## ALUMINUM WINDOWS

**05/19****Amendment 0003**

## 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 DAF45 (2003; Reaffirmed 2009) Designation System  
for Aluminum Finishes

## AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA 611 (2014) Voluntary Specification for  
Anodized Architectural Aluminum

AAMA 701/702 (2011) Voluntary Specification for Pile  
Weatherstripping and Replaceable  
Fenestration Weatherseals

AAMA 907 (2015) Voluntary Specification for  
Corrosion Resistant Coatings on Carbon  
Steel Components Used in Windows, Doors  
and Skylights

AAMA 1503 (2009) Voluntary Test Method for Thermal  
Transmittance and Condensation Resistance  
of Windows, Doors and Glazed Wall Sections

AAMA 2603 (2020) Voluntary Specification,  
Performance Requirements and Test  
Procedures for Pigmented Organic Coatings  
on Aluminum Extrusions and Panels

AAMA/WDMA/CSA 101/I.S.2/A440 (2017) North American Fenestration  
Standard/Specification for Windows, Doors,  
and Skylights

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

ASHRAE 169 (2021) Climate Data for Building Design  
Standards

## ASTM INTERNATIONAL (ASTM)

ASTM A276/A276M (2024) Standard Specification for  
Stainless Steel Bars and Shapes

ASTM E1300 (2024) Standard Practice for Determining

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#### Load Resistance of Glass in Buildings

ASTM F588 (2017) Standard Test Methods for Measuring the Forced Entry Resistance of Window Assemblies, Excluding Glazing Impact

ASTM F2248 (2012) Standard Practice for Specifying an Equivalent 3-Second Duration Design Loading for Blast Resistant Glazing Fabricated with Laminated Glass

#### INTERNATIONAL WINDOW CLEANING ASSOCIATION (IWCA)

IWCA I-14.1 (2001) Window Cleaning Safety Standard

#### NATIONAL FENESTRATION RATING COUNCIL (NFRC)

NFRC 100 (2020) Procedure for Determining Fenestration Product U-Factors

NFRC 200 (2020) Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence

#### NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 101 (2024) Life Safety Code

#### U.S. DEPARTMENT OF ENERGY (DOE)

Energy Star (1992; R 2006) Energy Star Energy Efficiency Labeling System (FEMP)

### 1.2 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

#### SD-02 Shop Drawings

Windows;

Fabrication Drawings

#### SD-03 Product Data

Windows;

Hardware;

Fasteners;

Window Performance;

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Thermal-Barrier Windows;

Mullions;

Window Cleaners' Bolts;

Screens;

Weatherstripping;

Accessories;

Adhesives

Thermal Performance;

Energy Star Label For Residential Aluminum Window Products; S

#### SD-04 Samples

Finish Sample

Window Sample

#### SD-05 Design Data

Structural Calculations for Deflection;

Design Analysis;

#### SD-06 Test Reports

Minimum Condensation Resistance Factor

#### SD-07 Certificates

Engineer's Qualifications

#### SD-10 Operation and Maintenance Data

Windows, Data Package 1;

Submit in accordance with Section 01 78 23 OPERATION AND  
MAINTENANCE DATA.

Plastic Identification

### 1.3 QUALITY ASSURANCE

#### 1.3.1 Qualification of Manufacturer

Window manufacturer must specialize in designing and manufacturing the type of aluminum windows specified in this section, and have a minimum of 20 years of documented successful experience. Manufacturer must have the facilities capable of meeting contract requirements, single-source responsibility and warranty.

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### 1.3.2 Shop Drawing Requirements

Take field measurements prior to preparation of drawings and fabrications. Provide drawings that indicate elevations of windows, full-size sections, thickness and gages of metal, fastenings, proposed method of anchoring, size and spacing of anchors, details of construction, method of glazing, details of operating hardware, mullion details, method and materials for weatherstripping, method of attaching screens, material and method of attaching subframes, stools, casings, sills, trim, installation details, and other related items.

### 1.3.3 Sample Requirements

#### 1.3.3.1 Finish Sample Requirements

Submit color chart of standard factory color coatings when factory-finish color coating is to be provided.

#### 1.3.3.2 Window Sample Requirements

Submit one full-size corner of each window type proposed for use. Where screens or weatherstripping is required, fit sample with such items that are to be used.

#### 1.3.3.3 Mock-Ups

Before fabrication, full-size mock-up of one window unit complete with glass and AAMA certification label for structural purposes and NFRC Temporary and Permanent Label for certification of thermal performance rating will be required for review of window construction and quality of hardware operation.

### 1.3.4 Design Data Requirements

Submit calculations to substantiate compliance with deflection requirements. A registered Professional Engineer must provide calculations.

Submit design analysis with calculations showing that the design of each different size and type of aluminum window unit and its anchorage to the structure Calculations verifying the structural performance of each window proposed for use, under the given loads, must be prepared and signed by a registered professional engineer. Reflect the window components and anchorage devices to the structure, as determined by the design analysis, in the shop drawings.

### 1.3.5 Test Report Requirements

Submit test reports for each type of window attesting that identical windows have been tested and meet the requirements specified herein for conformance to AAMA/WDMA/CSA 101/I.S.2/A440 including test size, and minimum condensation resistance factor (CRF).

### 1.3.6 Certification

Ensure that construction is performed with products that meet or exceed Energy Star criteria, .

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Each prime window unit must bear the AAMA Label warranting that the product complies with AAMA/WDMA/CSA 101/I.S.2/A440. Certified test reports attesting that the prime window units meet the requirements of AAMA/WDMA/CSA 101/I.S.2/A440, including test size, will be acceptable in lieu of product labeling.

#### 1.4 DELIVERY AND STORAGE

Deliver windows to project site in an undamaged condition. Use care in handling and hoisting windows during transportation and at the jobsite. Store windows and components out of contact with the ground, under a weathertight covering, so as to prevent bending, warping, or otherwise damaging the windows. Repair damaged windows to an "as new" condition as approved. If windows can not be repaired, provide a new unit.

#### 1.5 PLASTIC IDENTIFICATION

Label plastic products provided to indicate their polymeric composition according to the following list. Where products are not labeled, provide product data indicating polymeric information in Operation and Maintenance Manual.

- a. Type 1: Polyethylene Terephthalate (PET, PETE).
- b. Type 2: High Density Polyethylene (HDPE).
- c. Type 3: Vinyl (Polyvinyl Chloride or PVC).
- d. Type 4: Low Density Polyethylene (LDPE).
- e. Type 5: Polypropylene (PP).
- f. Type 6: Polystyrene (PS).
- g. Type 7: Other. Use of this code indicates that the package in question is made with a resin other than the six listed above, or is made of more than one resin listed above, and used in a multi-layer combination.

#### 1.6 PERFORMANCE REQUIREMENTS

##### 1.6.1 Wind Loading Design Pressure

Design window components, including mullions, hardware, and anchors, to withstand a wind-loading design pressure of at least 10 pounds per square foot (psf).

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##### 1.6.2 Tests

**Test windows proposed for use in accordance with AAMA/WDMA/CSA 101/I.S.2/A440 for the particular type and quality window specified.**

**Perform tests by a nationally recognized independent testing laboratory equipped and capable of performing the required tests. Submit the results of the tests as certified laboratory reports required herein.**

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## 1.7 DRAWINGS

Submit the Fabrication Drawings for aluminum window units showing complete window assembly including hardware, weatherstripping, and subframe assembly details.

## 1.8 WINDOW PERFORMANCE

Aluminum windows must meet the following performance requirements. Perform testing requirements by an independent testing laboratory or agency.

### 1.8.1 Structural Performance

Structural test pressures on window units must be for positive load (inward) and negative load (outward). After testing, there will be no glass breakage, permanent damage to fasteners, hardware parts, support arms or actuating mechanisms or any other damage which could cause window to be inoperable. There must be no permanent deformation of any main frame, sash or ventilator member in excess of the requirements established by AAMA/WDMA/CSA 101/I.S.2/A440 for the window types and classification specified in this section.

### 1.8.2 Air Infiltration

Air infiltration must not exceed the amount established by AAMA/WDMA/CSA 101/I.S.2/A440 for each window type.

### 1.8.3 Water Penetration

Water penetration must not exceed the amount established by AAMA/WDMA/CSA 101/I.S.2/A440 for each window type.

### 1.8.4 Thermal Performance

Windows (including frames and glass) will be independently tested and certified with a Solar Heat Gain Coefficient (SHGC) determined according to NFRC 200 procedures and a whole window U-factor determined in accordance with NFRC 100 within the ranges as indicated below according to the ASHRAE 169 Climate Zone of the project location. Provide visual Transmittance (VT) of 0.5 or greater. Submit documentation supporting compliance with Energy Star, FEMP designated, and Passive House qualifications as applicable. Provide proof of Energy Star label for residential aluminum window products.

#### 1.8.4.1 Northern Climate

Windows installed within Climate Zone 6 will have a U-Factor of 0.27 BTU/h·ft<sup>2</sup>·degrees F or less and a SHGC of 0.36 or less.

### 1.8.5 Life Safety Criteria

Provide windows that conform to NFPA 101 Life Safety Code when rescue and/or second means of escape are indicated.

## 1.9 WARRANTY

Provide Manufacturer's standard performance guarantees or warranties that extend beyond a 1 year period.

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## PART 2 PRODUCTS

### 2.1 WINDOWS

Provide prime windows that comply with AAMA/WDMA/CSA 101/I.S.2/A440 and the requirements specified herein. In addition to compliance with AAMA/WDMA/CSA 101/I.S.2/A440, window framing members for each individual light of glass must not deflect to the extent that deflection perpendicular to the glass light exceeds L/175 of the glass edge length when subjected to uniform loads at specified design pressures. Provide Structural calculations for deflection to substantiate compliance with deflection requirements. Provide windows of types, performance classes, performance grades, combinations, and sizes indicated or specified. Provide aluminum window frames with a minimum recycled content of 20 percent. Provide data identifying percentage of recycled content of aluminum windows. Design windows to accommodate hardware, glass, weatherstripping, screens, and accessories to be furnished. Each window must be a complete factory assembled unit with or without glass installed. Dimensions shown are minimum. Provide windows with insulating glass and thermal break necessary to achieve a minimum Condensation Resistance Factor (CRF) of n/a when tested in accordance with AAMA 1503. Provide manufacturer's standard hardware fabricated from aluminum, stainless steel, carbon steel complying with AAMA 907, or other corrosion-resistant material compatible with adjacent materials; designed to smoothly operate, tightly close, and securely lock windows, and sized to accommodate sash weight and dimensions.

#### 2.1.1 Fixed Windows (F)

Type F- CW30 -.

#### 2.1.2 Forced Entry Resistant Windows

In addition to meeting the requirements of AAMA/WDMA/CSA 101/I.S.2/A440, windows designated for resistance to forced entry must conform to the requirements of ASTM F588.

#### 2.1.3 Glass and Glazing

Materials are specified in Section 08 81 00 GLAZING.

#### 2.1.4 Caulking and Sealing

Are specified in Section 07 92 00 JOINT SEALANTS.

#### 2.1.5 Weatherstripping

AAMA/WDMA/CSA 101/I.S.2/A440. Provide for all ventilating (operable) sash for all windows. Provide woven wool pile weatherstripping 0.210 inch thick, conforming to AAMA 701/702, or polypropylene multifilament fiber weatherstripping installed in an integral weatherstripping groove in the sash or frame, and flexible polyvinylchloride weatherstripping installed in the sill member.

#### 2.1.6 Sash Poles

Seamless aluminum tube, 0.0625 inch minimum wall thickness, one inch diameter, feet long, with cast aluminum hook and protective cover or tip on the lower end. Finish must match windows.

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## 2.2 FABRICATION

Fabrication of window units must comply with AAMA/WDMA/CSA 101/I.S.2/A440.

### 2.2.1 Provisions for Glazing

Design windows and rabbets suitable for glass thickness shown . Design sash for double glazing and for securing glass with metal beads, or glazing compound.

### 2.2.2 Fasteners

Use window manufacturer's standard for windows, trim, and accessories. Self-tapping sheet-metal screws are not acceptable for material more than 1/16 inch thick.

### 2.2.3 Adhesives

Provide joint sealants as specified in Section 07 92 00 JOINT SEALANTS. For interior application of joint sealants, comply with applicable regulations regarding reduced VOC's, and as specified in Section 07 92 00 JOINT SEALANTS.

### 2.2.4 Drips and Weep Holes

Provide continuous drips over heads of top ventilators. Where fixed windows adjoin ventilators, drips must be continuous across tops of fixed windows. Provide drips and weep holes as required to return water to the outside.

### 2.2.5 Combination Windows

Windows used in combination must be factory assembled of the same class and grade. Where factory assembly of individual windows into larger units is limited by transportation considerations, prefabricate, match mark, transport, and field assemble.

### 2.2.6 Mullions and Transom Bars

Provide mullions between multiple window units to resist two times (2X) glazing resistance in accordance with ASTM F2248 and ASTM E1300. Provide mullions with a thermal break. Secure mullions and transom bars to adjoining construction and window units in such a manner as to permit expansion and contraction and to form a weathertight joint. Provide mullion covers on the interior and exterior to completely close exposed joints and recesses between window units and to present a neat appearance.

### 2.2.7 Accessories

Provide windows complete with necessary hardware, fastenings, clips, fins, anchors, glazing beads, and other appurtenances necessary for complete installation and proper operation.

#### 2.2.7.1 Hardware

AAMA/WDMA/CSA 101/I.S.2/A440. The item, type, and functional characteristics must be the manufacturer's standard for the particular window type. Provide hardware of suitable design and of sufficient

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strength to perform the function for which it is used. Equip all operating ventilators with a lock or latching device which can be secured from the inside.

#### 2.2.7.2 Fasteners

Provide concealed anchors of the type recommended by the window manufacturer for the specific type of construction. Anchors and fasteners must be compatible with the window and the adjoining construction. Provide a minimum of three anchors for each jamb located approximately 6 inches from each end and at midpoint.

#### 2.2.7.3 Window-Cleaner Anchors

Provide double head anchors for windows indicated. Anchors must be stainless steel of size and design required for the window type and application, conforming to ASTM A276/A276M. Provide two anchors for each single window and each adjacent fixed glass window unit. Fasten anchors 44 inches above the window sill utilizing appropriate methods for the window type and application in accordance with industry safety standards.

#### 2.2.7.4 Window Anchors

Anchoring devices for installing windows must be made of aluminum, cadmium-plated steel, stainless steel, or zinc-plated steel conforming to AAMA/WDMA/CSA 101/I.S.2/A440.

#### 2.2.8 Finishes

Comply with NAAMM's "Metal Finishes Manual" for applying and designating finishes. Exposed aluminum surfaces must be factory finished with an anodic coating. All windows must have the same finish.

##### 2.2.8.1 Anodic Coating

Clean exposed aluminum surfaces and provide an anodized finish conforming to AA DAF45 and AAMA 611. Finish must be:

- b. Architectural Class I ( 0.7 mil or thicker), designation AA-M10-C22-A44, electrolytically deposited color anodized.

##### 2.2.8.2 Organic Coating

Clean and prime exposed aluminum surfaces. Provide a baked enamel finish in accordance with AAMA 2603 with total dry film thickness not less than 0.8 mil.

#### 2.3 THERMAL-BARRIER WINDOWS

Provide thermal-barrier windows, complete with accessories and fittings, where indicated.

Specify material and construction except as follows:

- a. Aluminum alloy must be 6063-T6.
- b. Frame construction, including operable sash, must be factory-assembled and factory-sealed inner and outer aluminum completely separated from metal-to-metal contact. Join assembly by a continuous, concealed, low

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conductance divider housed in an interlocking extrusion of the inner frame. Metal fasteners, straps, or anchors must not bridge the connection between the inner and outer frame.

- c. Operating hardware for each sash must consist of spring-loaded nylon cushion blocks and pin locks designed to lock in predetermined locations.
- d. Sash must be completely separated from metal-to-metal contact by means of woven-pile weatherstripping, plastic, or elastomeric separation members.
- e. Operating and storm sash must be factory-glazed with the type of glass indicated and of the quality specified in Section 08 81 00 GLAZING.

## 2.4 MULLIONS

Provide mullions between multiple-window units where indicated.

Provide profiles for mullions and mullion covers, reinforced as required for the specified wind loading, and securely anchored to the adjoining construction. Mullion extrusion will include serrations or pockets to receive weatherstripping, sealant, or tape at the point of contact with each window flange.

Mullion assembly must include aluminum window clamps or brackets screwed or bolted to the mullion and the mullion cover.

Mullion cover must be screw-fastened to the mullion unless otherwise indicated.

Mullion reinforcing members must be fabricated of the materials specified in AAMA/WDMA/CSA 101/I.S.2/A440 and meet the specified design loading.

## 2.5 WINDOW CLEANERS' BOLTS

Provide window cleaners' bolts for all windows 7 feet or higher above finished grade, except for windows that can be removed and cleaned from the ground or from a lower roof level without the use of an extension ladder. Provide two bolts for each single window unit and each fixed glass unit. Locate bolts 44 inches above the window sill.

Window cleaners' bolts must be double-head type, AISI Series 300 corrosion-resistant steel, size and design complying with IWCA I-14.1. Contact side of the bolts must be ground to fit flat against window jambs. Bolts must be factory- or field-attached before windows are set. Reinforce backs of frames to receive bolts with 1/4 by 6-inch corrosion-resistant steel or aluminum plates bolted or welded to the frames at the factory. Special wall anchors must be provided on frames at the point of bolt attachment.

## PART 3 EXECUTION

### 3.1 INSTALLATION

#### 3.1.1 Method of Installation

Install in accordance with the window manufacturer's printed instructions and details. Build in windows as the work progresses or install without

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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. Protect ventilators and operating parts against accumulation of dirt and building materials by keeping ventilators tightly closed and locked to frame. 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 caulk windows in a manner that will prevent entrance of water and wind. Fasten insect screens securely in place.

Any materials that show visual evidence of biological growth due to the presence of moisture must not be installed on the building project.

### 3.1.2 Dissimilar Materials

Where aluminum surfaces are in contact with, or fastened to masonry, concrete, wood, or dissimilar metals, except stainless steel or zinc, protect the aluminum surface from dissimilar materials as recommended in the Appendix to AAMA/WDMA/CSA 101/I.S.2/A440. Do not coat surfaces in contact with sealants after installation with any type of protective material. Do not apply coatings or lacquers to surfaces to which caulking and glazing components must adhere.

### 3.1.3 Anchors and Fastenings

Make provision for securing units to each other, to masonry, and to other adjoining construction. Windows installed in masonry walls must have head and jamb members designed to recess into masonry wall not less than 7/16 inch.

### 3.1.4 Adjustments After Installation

After installation of windows and completion of glazing and field painting, adjust all 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 that products are properly installed, connected, and adjusted.

## 3.2 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 weather-stripping, and to prevent interference with the operation of hardware. Replace all stained, discolored, or abraded windows that cannot be restored to their original condition with new windows.

-- End of Section --

SECTION 08 81 00

GLAZING

**05/19**

**Amendment 0003**

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 800 (2016) Voluntary Specifications and Test  
Methods for Sealants

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z97.1 (2015) Safety Glazing Materials Used in  
Buildings - Safety Performance  
Specifications and Methods of Test

ASTM INTERNATIONAL (ASTM)

ASTM C509 (2006; R 2021) Standard Specification for  
Elastomeric Cellular Preformed Gasket and  
Sealing Material

ASTM C864 (2005; R 2015) Dense Elastomeric  
Compression Seal Gaskets, Setting Blocks,  
and Spacers

ASTM C920 (2018) Standard Specification for  
Elastomeric Joint Sealants

ASTM C1021 (2008; R 2014) Standard Practice for  
Laboratories Engaged in Testing of  
Building Sealants

ASTM C1036 (2021) Standard Specification for Flat  
Glass

ASTM C1048 (2018) Standard Specification for  
Heat-Strengthened and Fully Tempered Flat  
Glass

ASTM C1087 (2016) Standard Test Method for  
Determining Compatibility of  
Liquid-Applied Sealants with Accessories  
Used in Structural Glazing Systems

ASTM C1172 (2024) Standard Specification for  
Laminated Architectural Flat Glass

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|            |                                                                                      |
|------------|--------------------------------------------------------------------------------------|
| ASTM C1184 | (2023) Standard Specification for Structural Silicone Sealants                       |
| ASTM C1281 | (2016) Standard Specification for Preformed Tape Sealants for Glazing Applications   |
| ASTM D395  | (2016; E 2017) Standard Test Methods for Rubber Property - Compression Set           |
| ASTM D2287 | (2019) Nonrigid Vinyl Chloride Polymer and Copolymer Molding and Extrusion Compounds |
| ASTM E1300 | (2024) Standard Practice for Determining Load Resistance of Glass in Buildings       |
| ASTM E2190 | (2010) Standard Specification for Insulating Glass Unit Performance and Evaluation   |

#### GLASS ASSOCIATION OF NORTH AMERICA (GANA)

|                       |                                     |
|-----------------------|-------------------------------------|
| GANA Glazing Manual   | (2008) Glazing Manual               |
| GANA Sealant Manual   | (2008) Sealant Manual               |
| GANA Standards Manual | (2008) Engineering Standards Manual |

#### INSULATING GLASS MANUFACTURERS ALLIANCE (IGMA)

|              |                                                                                                                     |
|--------------|---------------------------------------------------------------------------------------------------------------------|
| IGMA TB-1200 | (1983; R 2016) Guidelines for Insulating Glass Dimensional Tolerances                                               |
| IGMA TB-3001 | (2001) Guidelines for Sloped Glazing                                                                                |
| IGMA TM-3000 | (1990; R 2016) North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial & Residential Use |

#### NATIONAL FENESTRATION RATING COUNCIL (NFRC)

|          |                                                                                                                                 |
|----------|---------------------------------------------------------------------------------------------------------------------------------|
| NFRC 100 | (2020) Procedure for Determining Fenestration Product U-Factors                                                                 |
| NFRC 200 | (2020) Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence |

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

|             |                                                     |
|-------------|-----------------------------------------------------|
| 16 CFR 1201 | Safety Standard for Architectural Glazing Materials |
|-------------|-----------------------------------------------------|

### 1.2 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification

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identifies the office that will review the submittal for the Government.  
Submit the following in accordance with Section 01 33 00 SUBMITTAL  
PROCEDURES:

SD-03 Product Data

Insulating Glass

Plastic Glazing

Glazing Accessories

Sealants

SD-04 Samples

Insulating Glass

Plastic Sheet

Glazing Compound

Glazing Tape

Sealing Tapes

SD-07 Certificates

Insulating Glass

Plastic Glazing

SD-08 Manufacturer's Instructions

Setting and Sealing Materials

Glass Setting

SD-11 Closeout Submittals

Warranty for Insulated Glass Units

1.3 SYSTEM DESCRIPTION

Fabricate and install watertight and airtight glazing systems to withstand thermal movement and wind loading without glass breakage, gasket failure, deterioration of glazing accessories, or defects in the work. Glazed panels must comply with the safety standards, in accordance with ANSI Z97.1, and comply with indicated wind/snow loading in accordance with ASTM E1300.

1.4 QUALITY CONTROL

Submit two 8 by 10 inch samples of each of the following: tinted glass, patterned glass, heat-absorbing glass, and insulating glass units.

Submit three samples of each other material. Samples of plastic sheets must be minimum 5 by 7 inches.

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## 1.5 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.

## 1.6 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.

## 1.7 WARRANTY

### 1.7.1 Warranty for Insulated 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.

### 1.7.2 Warranty for Polycarbonate Sheet

For a 5-year period following acceptance of the work:

- a. Warranty Type I, Class A (UV stabilized) sheets against breakage;
- b. Warranty Type III (coated, mar-resistant) sheets against breakage and against coating delamination;
- c. Warranty Type IV (coated sheet) against breakage and against yellowing;
- d. Warranty extruded polycarbonate profile sheet against breakage.

For a 10-year period following acceptance of the work, warranty Type IV against yellowing and loss of light transmission.

## PART 2 PRODUCTS

### 2.1 PRODUCT SUSTAINABILITY CRITERIA

### 2.2 GLASS

ASTM C1036, unless specified otherwise. In doors and sidelights, provide safety glazing material conforming to 16 CFR 1201.

#### 2.2.1 Clear Glass

Type I, Class 1 (clear), Quality q5 (B). Provide for glazing openings not indicated or specified otherwise. Use double-strength sheet glass or 1/8 inch float glass for openings up to and including 15 square feet, 3/16 inch

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for glazing openings over 15 square feet but not over 30 square feet, and 1/4 inch for glazing openings over 30 square feet but not over 45 square feet.

#### 2.2.2 Annealed Glass

Annealed glass must be Type I transparent flat type, Class 1 - clear, Quality q3 - glazing select, 51 percent light transmittance, .85 percent shading coefficient, conforming to ASTM C1036.

#### 2.2.3 Laminated Glass

ASTM C1172, Laminated glass fabricated from two nominal 1/8 inch pieces of Type I, Class 1, , Quality Q3, flat annealed ; clear glass conforming to ASTM C1036. Flat glass to be laminated together with a minimum of 0.030 inch inch thick, clear polyvinyl butyral laminate, conforming to requirements of 16 CFR 1201 and ASTM C1172. The total thickness of nominally 1/4 inches. Color to be clear . The total thickness of nominally 1/4 inch.

**Amendment 0003\*\*\*\*\***

#### 2.2.4 Tempered Glass

**ASTM C1048, Kind FT (fully tempered), Condition A (uncoated), Type I, Class 2 (tinted heat absorbing), Quality q3, 3/8" inch thick, 60 percent light transmittance, .50 percent shading coefficient conforming to ASTM C1048 and GANA Standards Manual. Color must be clear . Provide at windows type A & E noted as Specialty Glazing.**

**\*\*\*\*\*Amendment 0003**

#### 2.3 INSULATING GLASS UNITS

Two panes of glass separated by a dehydrated airspace, filled with argon gas and hermetically sealed, conforming to ASTM E2190. Submit performance and compliance documentation for each type of insulating glass.

Insulated glass units must have a Solar Heat Gain Coefficient (SHGC) maximum of .36 determined according to NFRC 200 and a U-factor maximum of .25 Btu per square foot by hr by degree F in accordance with NFRC 100.

Dimensional tolerances must be as specified in IGMA TB-1200. Spacer must be black, roll-formed, polyurethane and silicon foams, 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 must be compressed polyisobutylene and the secondary seal must be a specially formulated silicone.

The inner light must be ASTM C1172, clear annealed flat glass Type I, Class I, Quality q3 . The intermediate light must be ASTM C1172, clear annealed flat glass Type I, Class I, Quality q3 . The outer light must be ASTM C1036, Type I, Class 1 (transparent) , , Quality q4, inch thick .

#### 2.4 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

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unpainted must be gray or neutral color. Sealant testing must be performed by a testing agency qualified according to ASTM C1021.

Submit glass manufacturer's recommendations for setting and sealing materials and for installation of each type of glazing material specified.

#### 2.4.1 Putty and Glazing Compound

Provide glazing compound as recommended by manufacturer for face-glazing metal sash. Putty must be linseed oil type. Do not use putty and glazing compounds with insulating glass or laminated glass.

#### 2.4.2 Glazing Compound

Use for face glazing metal sash. Do not use with insulating glass units or laminated glass.

#### 2.4.3 Sealants

Provide elastomeric sealants.

##### 2.4.3.1 Elastomeric Sealant

ASTM C920, Type S, Grade NS, Class 12.5, Use G. Use for channel or stop glazing metal sash. Sealants must be chemically compatible with setting blocks, edge blocks, and sealing tapes, with sealants used in manufacture of insulating glass units. Color of sealant must be white.

##### 2.4.3.2 Structural Sealant

ASTM C1184, Type S.

#### 2.4.4 Glazing Tapes

##### 2.4.4.1 Back-Bedding Mastic Glazing Tapes

Preformed, butyl-based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; and complying with ASTM C1281 and AAMA 800 for products indicated below:

- a. AAMA 804.3 tape, where indicated.
- b. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
- c. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.

##### 2.4.4.2 Expanded Cellular Glazing Tapes

Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and complying with AAMA 800 for the following types:

- a. AAMA 810.1, Type 1, for glazing applications in which tape acts as the primary sealant.
- b. AAMA 810.1, Type 2, for glazing applications in which tape is used in

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combination with a full bead of liquid sealant.

#### 2.4.5 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 must be chemically compatible with the product being set.

#### 2.4.6 Setting Blocks and Edge Blocks

Closed-cell neoprene setting blocks must be dense extruded type conforming to ASTM C509 and ASTM D395, Method B, Shore A durometer between 70 and 90. Edge blocking must be Shore A durometer of 50 (plus or minus 5). Provide silicone setting blocks when blocks are in contact with silicone sealant. Profiles, lengths and locations must be as required and recommended in writing by glass manufacturer. Block color must be black.

#### 2.4.7 Glazing Gaskets

Glazing gaskets must 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 must be continuous one-piece units with factory-fabricated injection-molded corners free of flashing and burrs. Glazing gaskets must be in lengths or units recommended by manufacturer to ensure against pull-back at corners. Provide glazing gasket profiles as recommended by the manufacturer for the intended application.

##### 2.4.7.1 Fixed Glazing Gaskets

Fixed glazing gaskets must be closed-cell (sponge) smooth extruded compression gaskets of cured elastomeric virgin neoprene compounds conforming to ASTM C509, Type 2, Option 1.

##### 2.4.7.2 Wedge Glazing Gaskets

Wedge glazing gaskets must 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.

##### 2.4.7.3 Aluminum Framing Glazing Gaskets

Glazing gaskets for aluminum framing must be permanent, elastic, non-shrinking, non-migrating, watertight and weathertight.

#### 2.4.8 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. Use ASTM C1087 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of glazing sealants to surface.

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## PART 3 EXECUTION

Any materials that show visual evidence of biological growth due to the presence of moisture must not be installed on the building project.

### 3.1 PREPARATION

Preparation, unless otherwise specified or approved, must 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, must 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 Sheet Glass

Cut and set with the visible lines or waves horizontal.

#### 3.2.2 Patterned Glass

Set glass with one patterned surface with smooth surface on the weather side. When used for interior partitions, place the patterned surface in same direction in all openings.

#### 3.2.3 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 must conform to applicable recommendations of IGMA TB-3001 and IGMA TM-3000.

#### 3.2.4 Installation of Heat-Absorbing Glass

Provide glass with clean-cut, factory-fabricated edges. Field cutting will not be permitted.

#### 3.2.5 Installation of Laminated Glass

Sashes which are to receive laminated glass must be weeped to the outside to allow water drainage into the channel.

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### 3.3 CLEANING

Clean glass surfaces and remove labels, paint spots, putty, and other defacement as required to prevent staining. Glass must be clean at the time the work is accepted.

### 3.4 PROTECTION

Protect glass work immediately after installation. Identify glazed openings with suitable warning tapes, cloth or paper flags, attached with non-staining adhesives. Protect reflective glass with a protective material to eliminate any contamination of the reflective coating. Place protective material far enough away from the coated glass to allow air to circulate to reduce heat buildup and moisture accumulation on the glass. Upon removal, separate protective materials for reuse or recycling. Remove and replace glass units which are broken, chipped, cracked, abraded, or otherwise damaged during construction activities with new units.

### 3.5 SCHEDULE

Some metric measurements in this section are based on mathematical conversion of inch-pound measurements, and not on metric measurement commonly agreed to by the manufacturers or other parties. The inch-pound and metric measurements are as follows:

| <u>PRODUCTS</u>  | <u>INCH-POUND</u> | <u>METRIC</u> |
|------------------|-------------------|---------------|
| Glass            | 1/8 inch          | 3 mm          |
|                  | 3/16 inch         | 4.5 mm        |
|                  | 7/32 inch         | 6 mm          |
|                  | 1/4 inch          | 6 mm          |
|                  | 3/8 inch          | 10 mm         |
| Interlayer       | 0.015 inch        | 0.38 mm       |
| Glazing Channels | 1/4 inch          | 6 mm          |

-- End of Section --

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SECTION 09 06 00

SCHEDULES FOR FINISHES

**08/22**

**Amendment 0003**

PART 1 GENERAL

1.1 SUMMARY

This section covers only the color of exterior and interior materials and products that are exposed to view in the finished construction. The word "color", as used herein, includes surface color and pattern. Requirements for quality, product specifications, and method of installation are covered in other appropriate sections of the specifications. Specific locations where the various materials are required are shown on the drawings if not identified in this specification. Items not designated for color in this section may be specified in other sections. When color is not designated for items, propose a color for approval.

1.2 SUBMITTALS

SD-04 Samples

Contractor Color Boards; G,

1.3 COLOR REFERENCE SYSTEMS

Colors for project finishes are identified in the Color Schedule and based on the Existing facility Colors to be matched. color reference system.

PART 2 PRODUCTS

2.1 CONTRACTOR COLOR BOARDS

Contractor to submit actual color boards to include all finish color samples specified on the project, prior to the submittal and approval of individual finish submittals. The DOR must review and approve the color boards to verify overall building finish coordination and aesthetic. Color boards must be prepared by professional interior designers or architects with significant interior design experience. Qualification of designers is based on education, experience and examination. Interior designers or architects must have completed a program accredited by the Council for Interior Design Accreditation (CIDA) or equal accreditation program of academic training in interior design. In addition, the interior designer or architect must also have attained National Council for Interior Design Qualification (NCIDQ) certification or state licensure, certification or registration and must not be affiliated with a furniture dealership, vendor or manufacturer.

2.2 COLOR SCHEDULE

The color information provided in the following paragraphs lists the colors, patterns and textures for exterior and interior finishes, including both factory applied and field applied colors. In the case of difference between the drawings and specifications, colors identified in this specification govern.

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## 2.3 EXTERIOR FINISHES

### 2.3.1 Exterior Walls

Exterior wall colors apply to exterior wall surfaces including recesses at entrances and projecting vestibules. When applicable, paint conduit to closely match the adjacent surface color. Provide wall colors to match the colors listed below.

#### 2.3.1.1 Mortar

To match existing.

#### 2.3.1.2 Concrete Masonry Units

#### 2.3.1.3 Insulation and Finish System

2 colors to be picked by the Contracting Officer from selected manufacturer's standard colors during the submittal process.

#### 2.3.1.4 Glass and Glazing

Clear

#### 2.3.1.5 Paint

To match existing colors. Final selections by Contracting Officer from selected manufacturer's standard colors during the submittal process.

### 2.3.2 Exterior Trim

Provide exterior trim to match the colors listed below.

#### 2.3.2.1 Steel Doors and Door Frames

Paint to match existing.

#### 2.3.2.2 Aluminum Doors and Door Frames

Integral color to match existing.

#### 2.3.2.3 Aluminum Windows (mullion, muntin, sash, trim, and sill)

Integral color to match existing.

#### 2.3.2.4 Downspouts and Gutters

To match existing.

#### 2.3.2.5 Flashings

Match adjacent material in color.

#### 2.3.2.6 Caulking and Sealants

Match adjacent material in color.

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#### 2.3.2.7 Signage

To match existing.

#### 2.3.2.8 Control Joints

Match adjacent material in color.

#### 2.3.2.9 Expansion Joint and/or Covers

Match adjacent material in color.

### 2.4 INTERIOR FINISHES

#### 2.4.1 Interior Floor Finishes

Provide flooring materials to match the colors listed below.

##### 2.4.1.1 Porcelain Tile

As selected by the Contracting Officer from the selected manufacturer's standard colors during the submittal process.

##### 2.4.1.2 Ceramic Tile

As selected by the Contracting Officer from the selected manufacturer's standard colors during the submittal process.

##### 2.4.1.3 Grout

As selected by the Contracting Officer from the selected manufacturer's standard colors during the submittal process.

**Amendment 0003\*\*\*\*\***

##### 2.4.1.4 Quartz Transition

**DELETED**

**\*\*\*\*\*Amendment 0003**

#### 2.4.2 Interior Base Finishes

Provide base materials to match the colors listed below.

##### 2.4.2.1 Resilient Base and Moldings

As selected by the Contracting Officer from the selected manufacturer's standard colors during the submittal process. Final color to match existing.

##### 2.4.2.2 Porcelain Tile

As selected by the Contracting Officer from the selected manufacturer's standard colors during the submittal process.

##### 2.4.2.3 Grout

As selected by the Contracting Officer from the selected

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manufacturer's standard colors during the submittal process.

**Amendment 0003\*\*\*\*\***

2.4.2.4 Integral Cove Base

**DELETED**

2.4.2.5 Brick

**DELETED**

**\*\*\*\*\*Amendment 0003**

2.4.2.6 Mortar

As selected by the Contracting Officer from the selected manufacturer's standard colors during the submittal process. Final color to match existing adjacent color.

2.4.2.7 Paint

As selected by the Contracting Officer from the selected manufacturer's standard colors during the submittal process. Final color to match existing adjacent color.

2.4.3 Interior Wall Finishes

Apply interior wall color to the entire wall surface, including reveals, vertical furred spaces and columns, grilles, diffusers, electrical and access panels, and piping and conduit adjacent to wall surfaces unless otherwise specified. Paint items not specified in other paragraphs to match adjacent wall surface. Provide wall materials to match the colors listed below.

2.4.3.1 Paint

As selected by the Contracting Officer from the selected manufacturer's standard colors during the submittal process. Final color to match existing adjacent color.

2.4.4 Interior Ceiling Finishes

Apply ceiling colors to ceiling surfaces including soffits, furred down areas, grilles, diffusers, registers, and access panels. In addition, apply ceiling color to joists, underside of roof deck, and conduit and piping where joists and deck are exposed and required to be painted. Provide ceiling materials to match the colors listed below.

2.4.4.1 Acoustical Tile and Grid

Manufacturers Standard Color

2.4.4.2 Paint (Ceilings)

As selected by the Contracting Officer from the selected manufacturer's standard colors during the submittal process. Final color to match existing adjacent color.

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2.4.4.3 Paint (Soffits)

As selected by the Contracting Officer from the selected manufacturer's standard colors during the submittal process. Final color to match existing adjacent color.

2.4.5 Interior Trim

Provide interior trim to match the colors listed below.

2.4.5.1 Steel Doors

As selected by the Contracting Officer from the selected manufacturer's standard colors during the submittal process. Final color to match existing Steel Doors.

2.4.5.2 Steel Door Frames

As selected by the Contracting Officer from the selected manufacturer's standard colors during the submittal process. Final color to match existing Steel Door Frames.

2.4.5.3 Aluminum Doors and Door Frames

As selected by the Contracting Officer from the selected manufacturer's standard colors during the submittal process. Final color to match existing exterior Aluminum Doors and Windows.

2.4.5.4 Aluminum Windows (mullion, muntin, sash, trim, and stool)

As selected by the Contracting Officer from the selected manufacturer's standard colors during the submittal process. Final color to match existing windows.

2.4.5.5 Exposed Ductwork

As selected by the Contracting Officer.

2.4.6 Interior Miscellaneous

Provide miscellaneous items to match the colors listed below.

2.4.6.1 Solid Surfacing Material

As selected by the Contracting Officer.

2.4.6.2 Signage Message Color

As selected by the Contracting Officer.

2.4.6.3 Signage Background Color

To match existing as selected by the Contracting Officer.

2.4.6.4 Lockers

As selected by the Contracting Officer.

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2.4.6.5 Benches

As selected by the Contracting Officer.

2.4.6.6 Wall Switch Handles and Standard Receptacle Bodies

To match existing.

2.4.6.7 Electrical Device Cover Plates

To match existing.

2.4.6.8 Electrical Panels

To match existing.

PART 3 EXECUTION

Not Used

-- End of Section --

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## SECTION 09 29 00

## GYPSUM BOARD

**08/24****Amendment 0003**

## 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 A653/A653M   | (2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process                                                              |
| ASTM C475/C475M   | (2017; R 2022) Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board                                                                                                   |
| ASTM C514         | (2004; R 2020) Standard Specification for Nails for the Application of Gypsum Board                                                                                                                  |
| ASTM C557         | (2003; R 2017) Standard Specification for Adhesives for Fastening Gypsum Wallboard to Wood Framing                                                                                                   |
| ASTM C840         | (2023) Standard Specification for Application and Finishing of Gypsum Board                                                                                                                          |
| ASTM C954         | (2022) Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness |
| ASTM C1002        | (2022) 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        | (2019) Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base                                                                                                            |
| ASTM C1396/C1396M | (2017) Standard Specification for Gypsum Board                                                                                                                                                       |
| ASTM D226/D226M   | (2017) Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing                                                                                                   |

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CALIFORNIA DEPARTMENT OF PUBLIC HEALTH (CDPH)

CDPH SECTION 01350 (2017; Version 1.2) Standard Method for  
the Testing and Evaluation of Volatile  
Organic Chemical Emissions from Indoor  
Sources using Environmental Chambers

GREEN SEAL (GS)

GS-36 (2013) Adhesives for Commercial Use

GYPSUM ASSOCIATION (GA)

GA 214 (2010) Recommended Levels of Gypsum Board  
Finish

GA 216 (2016) Application and Finishing of Gypsum  
Panel Products

SCIENTIFIC CERTIFICATION SYSTEMS (SCS)

SCS SCS Global Services (SCS) Indoor Advantage

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)

SCAQMD Rule 1168 (2022) Adhesive and Sealant Applications

UL SOLUTIONS (UL)

UL 2818 (2022) GREENGUARD Certification Program  
For Chemical Emissions For Building  
Materials, Finishes And Furnishings

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

### SD-02 Shop Drawings

Control Joint Shop Drawings

### SD-03 Product Data

Gypsum Board

Glass Mat Moisture-Resistant Gypsum Tile Backing Board

Moisture- and Mold-Resistant Gypsum Backing Board

Glass Mat Covered or Reinforced Gypsum Sheathing

Glass Mat Covered or Reinforced Gypsum Sheathing Sealant

Accessories

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VOC Content of Joint Compound; S

SD-04 Samples

SD-06 Test Reports

SD-07 Certificates

Asbestos Free Materials; G,

Indoor Air Quality for Gypsum Board; S

Indoor Air Quality for Non-aerosol Adhesives; S

Indoor Air Quality for Aerosol Adhesives; S

### 1.3 CERTIFICATIONS

#### 1.3.1 Indoor Air Quality Certifications

Submit required indoor air quality certifications in one submittal package.

##### 1.3.1.1 Ceiling and Wall Systems

Provide products certified to meet indoor air quality requirements by UL 2818 (Greenguard) Gold, SCS Global Services Indoor Advantage Gold or provide certification or validation by other third-party program that products meet the requirements of this Section. Provide current product certification documentation from certification body. When product does not have certification, provide validation that product meets the indoor air quality product requirements cited herein.

##### 1.3.1.2 Adhesives and Sealants

Provide products certified to meet indoor air quality requirements by UL 2818 (Greenguard) Gold, SCS Global Services Indoor Advantage Gold or provide certification or validation by other third-party program that products meet the requirements of this Section. Provide adhesive products certified to meet ASTM C557. Provide current product certification documentation from certification body. When product does not have certification, provide validation that product meets the indoor air quality product requirements cited herein.

### 1.4 DELIVERY, STORAGE, AND HANDLING

#### 1.4.1 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.

#### 1.4.2 Storage

Keep materials dry by storing inside a sheltered building. Where necessary to store gypsum board, glass mat faced gypsum board, and cementitious backer units outside, store flat and 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

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ventilation to prevent condensation. Remove plastic wrapping that may inhibit ventilation. Store per manufacturer's recommendations for allowable temperature and humidity range. Do not store panels where temperatures may exceed 125 deg F. Do not store panels near materials that may offgas or emit harmful fumes, such as kerosene heaters, fresh paint, or adhesives. Do not use materials that have visible moisture or biological growth. Do not stack panels higher than manufacturer's recommendations, and no higher than 17 feet.

#### 1.4.3 Handling

Neatly stack gypsum board, glass mat faced gypsum board, and cementitious backer units flat to prevent sagging or damage to the edges, ends, and surfaces. Handle per manufacturer's recommendations.

#### 1.5 QUALIFICATIONS

Furnish type of gypsum board work specialized by the installer with a minimum of 3 years of documented successful experience.

#### 1.6 ENVIRONMENTAL REQUIREMENTS

Do not expose the gypsum board to excessive sunlight prior to gypsum board application. Maintain a continuous uniform temperature of not less than 50 degrees F and not more than 80 degrees F for at least one week prior to the application of gypsum board work, while the gypsum board application is being done, and for at least one week after the gypsum board is set. Shield air supply and distribution devices to prevent any uneven flow of air across the plastered surfaces. Provide ventilation to exhaust moist air to the outside during gypsum board application, set, and until gypsum board jointing is dry. In glazed areas, keep windows open top and bottom or side to side 3 to 4 inches. Reduce openings in cold weather to prevent freezing of joint compound when applied. For enclosed areas lacking natural ventilation, provide temporary mechanical means for ventilation. In unglazed areas subjected to hot, dry winds or temperature differentials from day to night of 20 degrees F or more, screen openings with cheesecloth or similar materials. Avoid rapid drying. During periods of low indoor humidity, provide minimum air circulation following gypsum boarding and until gypsum board jointing complete and is dry.

### PART 2 PRODUCTS

#### 2.1 MATERIALS

Conform to specifications, standards and requirements specified. Provide gypsum board types, gypsum backing board types, cementitious backing units, and joint treating materials manufactured from asbestos free materials only.

##### 2.1.1 Gypsum Board

ASTM C1396/C1396M. Gypsum Board must not contain asbestos. Provide gypsum wall board and panels meeting the emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type). Provide certification or validation of indoor air quality for gypsum board.

##### 2.1.1.1 Regular

48 inch wide, 5/8 inch thick, tapered edges. Provide tapered and featured

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edge gypsum board as indicated.

#### 2.1.1.2 Type X (Special Fire-Resistant)

48 inch wide, 5/8 inch thick, tapered edges.

#### 2.1.2 Joint Treatment Materials

ASTM C475/C475M. Product must be low emitting VOC types with VOC limits not exceeding 50 g/L. Joint materials must not contain asbestos. Provide data identifying VOC content of joint compound. Use all purpose joint and texturing compound containing inert fillers and natural binders, including lime compound. Pre-mixed compounds must 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 Nails

ASTM C514.

##### 2.1.3.2 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.

##### 2.1.3.3 Staples

No. 16 USS gage flattened galvanized wire staples with 7/16 inch wide crown outside measurement and divergent point for base ply of two-ply gypsum board application. Use as follows:

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| <u>Length of Legs</u> | <u>Thickness of Gypsum Board</u> |
|-----------------------|----------------------------------|
| 1-1/8 inches          | 1/2 inch                         |
| 1-1/4 inches          | 5/8 inch                         |

#### 2.1.4 Adhesives

Provide non-aerosol adhesive products used on the interior of the building (defined as inside of the weatherproofing system) meeting either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of SCAQMD Rule 1168. Provide aerosol adhesive products used on the interior of the building (defined as inside of the weatherproofing system) meeting either emissions requirements of CDPH SECTION 01350 (limit requirements for either office or classroom spaces regardless of space type) or VOC content requirements of GS-36. Provide certification or validation of indoor air quality for non-aerosol adhesives applied on the interior of the building (inside of the weatherproofing system). Provide certification or validation of indoor air quality for aerosol adhesives used on the interior of the building (inside of the weatherproofing system).

##### 2.1.4.1 Adhesive for Fastening Gypsum Board to Metal Framing

Type recommended by gypsum board manufacturer.

##### 2.1.4.2 Adhesive for Fastening Gypsum Board to Wood Framing

ASTM C557.

##### 2.1.4.3 Adhesive for Laminating

Adhesive attachment is not permitted for multi-layer gypsum boards. For laminating gypsum studs to face panels, provide adhesive recommended by gypsum board manufacturer.

#### 2.1.5 Gypsum Studs

Provide 1 inch minimum thickness and 6 inch minimum width. Studs may be of 1 inch thick gypsum board or multilayers fastened to required thickness. Conform to ASTM C1396/C1396M for material and GA 216 for installation.

#### 2.1.6 Accessories

ASTM C1047. Fabricate from corrosion protected steel designed for intended use. Accessories manufactured with paper flanges are not acceptable. Flanges must be free of dirt, grease, and other materials that may adversely affect bond of joint treatment. Provide prefinished or job decorated materials.

##### 2.1.6.1 Trim

Provide trim for plaster including, as required:

- a. Cornerbeads.
- b. Bullnose Beads.

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- c. LC Beads.
- d. L-Beads.
- e. U-Beads.
- f. Control Joints.
- g. Curved-edge Cornerbeads.
- h. Base-of-wall Trim.
- i. Trim required to complete the work.

#### 2.1.6.2 Materials

Steel: ASTM A653/A653M Galvanized steel assemblies and fasteners.

#### 2.1.7 Asphalt Impregnated Building Felt

Provide a 15 lb asphalt moisture barrier over glass mat covered or reinforced gypsum sheathing. Conforming to ASTM D226/D226M Type 1 (No. 15) for asphalt impregnated building felt.

#### 2.1.8 Water

Provide clean, fresh, and potable water.

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#### 2.1.9 Sound Attenuation Blankets

**ASTM C665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.**

**\*\*\*\*\*Amendment 0003**

### 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 and cementitious backer units. 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 and cementitious backer units.

##### 3.1.2 Gypsum Board and Framing

Verify that surfaces of gypsum board and framing to be bonded with an adhesive are free of dust, dirt, grease, and any other foreign matter. Do not proceed with work until surfaces are acceptable for application of gypsum board with adhesive.

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### 3.1.3 Building Construction Materials

Do not install building construction materials that show visual evidence of biological growth.

## 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. Apply gypsum board with separate panels in moderate contact; do not force in place. Stagger end joints of adjoining panels. Neatly fit abutting end and edge joints. Use gypsum board of maximum practical length; select panel sizes to minimize waste. Cut out gypsum board to make neat, close, and tight joints around openings. In vertical application of gypsum board, provide panels in lengths required to reach full height of vertical surfaces in one continuous piece. Lay out panels to minimize waste; reuse cutoffs whenever feasible. Surfaces of gypsum board and substrate members may be bonded together with an adhesive, except where prohibited by fire rating(s). Treat edges of cutouts for plumbing pipes, screwheads, and joints with moisture-resistant compound as recommended by the gypsum board manufacturer. Minimize framing by floating corners with single studs and drywall clips. Install 5/8 inch gypsum or ceiling board over framing at 24 inch on center. Provide type of gypsum board for use in each system specified herein as indicated.

### 3.2.1 Application of Single-Ply Gypsum Board to Wood Framing

Apply in accordance with ASTM C840, System I or GA 216.

### 3.2.2 Application of Two-Ply Gypsum Board to Wood Framing

Apply in accordance with ASTM C840, System II or GA 216.

### 3.2.3 Adhesive Nail-On Application to Wood Framing

Apply in accordance with ASTM C840, System III or GA 216. This method may be used in lieu of ASTM C840, System I at the option of the Contractor.

### 3.2.4 Semi-Solid Gypsum Board Partitions

Provide in accordance with ASTM C840, System IV or GA 216.

### 3.2.5 Solid Gypsum Board Partitions

Provide in accordance with ASTM C840, System V or GA 216.

### 3.2.6 Adhesive Application to Interior Masonry or Concrete Walls

Apply in accordance with ASTM C840, System VI or GA 216.

### 3.2.7 Application of Gypsum Board to Steel Framing and Furring

Apply in accordance with ASTM C840, System VIII or GA 216.

### 3.2.8 Arches and Bending Radiuses

Apply gypsum board in accordance with ASTM C840, System IX or GA 216.

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### 3.2.9 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.

### 3.2.10 Control Joints

Install expansion and contraction joints in ceilings and walls in accordance with ASTM C840, System XIII or GA 216. Joints in fire-rated and sound-rated ceiling and walls to maintain the fire and sound rating.

#### 3.2.10.1 Control Joint Shop Drawings

- a. Submit control joint shop drawings for approval.
- b. Install control joints where a partition, wall, or ceiling traverses a construction joint in the base building structure.
- c. Install control joints where a wall or partition runs in an uninterrupted straight plane exceeding 30 feet.
- d. Install control joints in interior ceilings with a perimeter relief so that linear dimensions between control joints do not exceed 50 feet.
- e. Install control joints in interior ceilings without perimeter relief so that linear dimensions between control joints do not exceed 30 feet.
- f. Install control joints in exterior ceilings and soffits so that linear dimensions between control joints do not exceed 30 feet.
- g. Install control joints or intermediate blocking where ceiling framing members change direction.
- h. In addition to the above, install control joints where indicated on the drawings as a design accent or architectural feature.
- i. Do not install control joints where building or structural expansion or seismic joints are located. Install suitable joint expansion or seismic joint assemblies as indicated on the drawings.

### 3.3 FINISHING OF GYPSUM BOARD

Tape and finish gypsum board in accordance with ASTM C840, GA 214, and GA 216. Finish plenum areas above ceilings to Level 1 in accordance with GA 214. Finish moisture-resistant gypsum backing board, ASTM C1396/C1396M, to receive ceramic tile to Level 2 in accordance with GA 214. Finish walls and ceilings to receive a heavy-grade wall covering or heave textured finish before painting to Level 3 in accordance with GA 214. Finish walls and ceilings without critical lighting to receive flat paints, light textures, or wall coverings to Level 4 in accordance with GA 214. Unless otherwise specified, finish all gypsum board walls, partitions, and ceilings to Level 5 in accordance with GA 214. Provide joint, fastener depression, and corner treatment. Tool joints as smoothly as possible to minimize sanding and dust. Do not use self-adhering fiber glass mesh tape with conventional drying type joint compounds; use setting or hardening type compounds only. Provide treatment for moisture-resistant gypsum board as recommended by the gypsum board manufacturer. Protect workers, building

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occupants, and HVAC systems from gypsum dust.

### 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 --

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SECTION 09 90 00

PAINTS AND COATINGS

**02/21**

**Amendment 0003**

PART 1 GENERAL

1.1 RELATED REQUIREMENTS

1.1.1 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.
- c. Existing coated surfaces that are damaged during performance of the work.

1.1.1.1 Exterior Painting

Includes new surfaces, existing coated surfaces, and existing uncoated surfaces, of the building and appurtenances. Also included are existing coated surfaces made bare by cleaning operations.

1.1.1.2 Interior Painting

Includes new surfaces, existing uncoated surfaces, and existing coated surfaces of the building and appurtenances as indicated and existing coated surfaces made bare by cleaning operations. Where a space or surface is indicated to be painted, include the following items, unless indicated otherwise.

- a. Exposed columns, girders, beams, joists, and metal deck; and
- b. Other contiguous surfaces.

1.1.2 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, anodized aluminum, brass, and lead

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except existing coated surfaces.

- e. Hardware, fittings, and other factory finished items.

#### 1.1.3 Mechanical and Electrical Painting

Includes field coating of interior and exterior new and existing 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.

##### 1.1.3.1 Fire Extinguishing Sprinkler Systems

Clean, pretreat, prime, and paint new fire extinguishing sprinkler systems including valves, piping, conduit, hangers, supports, miscellaneous metalwork, and accessories. Apply coatings to clean, dry surfaces, using clean brushes.

#### 1.2 REFERENCES

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

##### AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS (ACGIH)

|            |                                                                                                |
|------------|------------------------------------------------------------------------------------------------|
| ACGIH 0100 | (2017; Suppl 2020) Documentation of the Threshold Limit Values and Biological Exposure Indices |
|------------|------------------------------------------------------------------------------------------------|

##### ASTM INTERNATIONAL (ASTM)

|            |                                                                                                                 |
|------------|-----------------------------------------------------------------------------------------------------------------|
| ASTM C920  | (2018) Standard Specification for Elastomeric Joint Sealants                                                    |
| ASTM D235  | (2022) Standard Specification for Mineral Spirits (Petroleum Spirits) (Hydrocarbon Dry Cleaning Solvent)        |
| ASTM D523  | (2014; R 2018) Standard Test Method for Specular Gloss                                                          |
| ASTM D4214 | (2007; R 2015) Standard Test Method for Evaluating the Degree of Chalking of Exterior Paint Films               |
| ASTM D4263 | (1983; R 2018) Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method             |
| ASTM D4444 | (2013; R 2018) Standard Test Method for Laboratory Standardization and Calibration of Hand-Held Moisture Meters |

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|            |                                                                                                                                        |
|------------|----------------------------------------------------------------------------------------------------------------------------------------|
| ASTM D6386 | (2022) Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting |
| ASTM F1869 | (2023) Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride           |

CENTERS FOR DISEASE CONTROL AND PREVENTION (CDC)

|                          |                                                                 |
|--------------------------|-----------------------------------------------------------------|
| Intelligence Bulletin 65 | (2013) Occupational Exposure to Carbon Nanotubes and Nanofibers |
|--------------------------|-----------------------------------------------------------------|

MASTER PAINTERS INSTITUTE (MPI)

|              |                                                                                        |
|--------------|----------------------------------------------------------------------------------------|
| MPI 3        | (2016) Primer, Alkali Resistant, Water Based                                           |
| MPI 4        | (2016) Interior/Exterior Latex Block Filler                                            |
| MPI 44       | (2016) Latex, Interior, (MPI Gloss Level 2)                                            |
| MPI 50       | (2015) Primer Sealer, Latex, Interior                                                  |
| MPI 52       | (2016) Latex, Interior, (MPI Gloss Level 3)                                            |
| MPI 54       | (2016) Latex, Interior, Semi-Gloss (MPI Gloss Level 5)                                 |
| MPI 77       | (2015) Epoxy, Gloss                                                                    |
| MPI 101      | (2016) Primer, Epoxy, Anti-Corrosive, for Metal                                        |
| MPI 107      | (2016) Primer, Rust-Inhibitive, Water Based                                            |
| MPI 116      | (2012) Block Filler, Epoxy                                                             |
| MPI 119      | (2016) Latex, Exterior, Gloss (MPI Gloss Level 6)                                      |
| MPI 134      | (2015) Primer, Galvanized, Water Based                                                 |
| MPI 141      | (2016) Latex, Interior, High Performance Architectural, Semi-Gloss (MPI Gloss Level 5) |
| MPI ASM      | (2019) Architectural Painting Specification Manual                                     |
| MPI GPS-1-14 | (2014) Green Performance Standard GPS-1-14                                             |
| MPI GPS-2-14 | (2014) Green Performance Standard GPS-2-14                                             |
| MPI MRM      | (2015) Maintenance Repainting Manual                                                   |

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#### SOCIETY FOR PROTECTIVE COATINGS (SSPC)

|                        |                                                                                                           |
|------------------------|-----------------------------------------------------------------------------------------------------------|
| SSPC 7/NACE No.4       | (2007) Brush-Off Blast Cleaning                                                                           |
| SSPC Glossary          | (2011) SSPC Protective Coatings Glossary                                                                  |
| SSPC Guide 6           | (2021) Guide for Containing Surface Preparation Debris Generated During Paint Removal Operations          |
| SSPC Guide 7           | (2015) Guide to the Disposal of Lead-Contaminated Surface Preparation Debris                              |
| SSPC PA 1              | (2024) Shop, Field, and Maintenance Coating of Metals                                                     |
| SSPC SP 1              | (2015) Solvent Cleaning                                                                                   |
| SSPC SP 2              | (2018) Hand Tool Cleaning                                                                                 |
| SSPC SP 3              | (2018) Power Tool Cleaning                                                                                |
| SSPC SP 6/NACE No.3    | (2007) Commercial Blast Cleaning                                                                          |
| SSPC SP 10/NACE No. 2  | (2015) Near-White Blast Cleaning                                                                          |
| SSPC VIS 1             | (2002; E 2004) Guide and Reference Photographs for Steel Surfaces Prepared by Dry Abrasive Blast Cleaning |
| SSPC VIS 3             | (2004) Guide and Reference Photographs for Steel Surfaces Prepared by Hand and Power Tool Cleaning        |
| SSPC VIS 4/NACE VIS 7  | (1998; E 2000; E 2004) Guide and Reference Photographs for Steel Surfaces Prepared by Waterjetting        |
| SSPC-SP WJ-1/NACE WJ-1 | (2012) Clean to Bare Substrate, Waterjet Cleaning of Metals                                               |
| SSPC-SP WJ-2/NACE WJ-2 | (2012) Very Thorough Cleaning, Waterjet Cleaning of Metals                                                |
| SSPC-SP WJ-3/NACE WJ-3 | (2012) Thorough Cleaning, Waterjet Cleaning of Metals                                                     |
| SSPC-SP WJ-4/NACE WJ-4 | (2012) Light Cleaning, Waterjet Cleaning of Metals                                                        |

#### U.S. ARMY CORPS OF ENGINEERS (USACE)

|            |                                                                    |
|------------|--------------------------------------------------------------------|
| EM 385-1-1 | (2024) Safety -- Safety and Occupational Health (SOH) Requirements |
|------------|--------------------------------------------------------------------|

#### U.S. GENERAL SERVICES ADMINISTRATION (GSA)

|             |                              |
|-------------|------------------------------|
| FED-STD-313 | (2018) Material Safety Data, |
|-------------|------------------------------|

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Transportation Data and Disposal Data for  
Hazardous Materials Furnished to  
Government Activities

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

|                  |                  |
|------------------|------------------|
| 29 CFR 1910.1000 | Air Contaminants |
| 29 CFR 1910.1025 | Lead             |
| 29 CFR 1926.62   | Lead             |

### 1.3 DEFINITIONS

#### 1.3.1 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.

#### 1.3.2 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 must be accomplished by an MPI testing lab.

#### 1.3.3 Coating

SSPC Glossary; (1) A liquid, liquefiable, or mastic composition that is converted to a solid protective, decorative, or functional adherent film after application as a thin layer; (2) Generic term for paint, lacquer, enamel.

#### 1.3.4 DFT or dft

Dry film thickness, the film thickness of the fully cured, dry paint or coating.

#### 1.3.5 DSD

Degree of Surface Degradation, the MPI system of defining degree of surface degradation. Five levels are generically defined under the Assessment sections in the MPI MRM, MPI Maintenance Repainting Manual.

#### 1.3.6 EXT

MPI short term designation for an exterior coating system.

#### 1.3.7 INT

MPI short term designation for an interior coating system.

#### 1.3.8 Loose Paint

Paint or coating that can be removed with a dull putty knife.

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### 1.3.9 mil / mils

The English measurement for 0.001 in or one one-thousandth of an inch.

### 1.3.10 MPI Gloss Levels

MPI system of defining gloss. Seven 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<br>degree angle | Units at 80<br>degree angle |
|-------------|---------------|-----------------------------|-----------------------------|
| 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).

### 1.3.11 MPI System Number

The MPI coating system number in each MPI 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).

### 1.3.12 Paint

SSPC Glossary; (1) Any pigmented liquid, liquefiable, or mastic composition designed for application to a substrate in a thin layer that is converted to an opaque solid film after application. Used for protection, decoration, identification, or to serve some other functional purposes; (2) Application of a coating material.

### 1.3.13 REX

MPI short term designation for an exterior coating system used in repainting projects or over existing coating systems.

### 1.3.14 RIN

MPI short term designation for an interior coating system used in repainting projects or over existing coating systems.

**Amendment 0003\*\*\*\*\***

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#### 1.4 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

Samples of specified materials may be taken and tested for compliance with specification requirements.

##### SD-02 Shop Drawings

Piping Identification

##### SD-03 Product Data

Coating;

Product Data Sheets

Sealant

##### SD-04 Samples

Color;

##### SD-07 Certificates

Qualification Testing laboratory for coatings;

Indoor Air Quality for Paints and Primers

Indoor Air Quality for Consolidated Latex Paints

##### SD-08 Manufacturer's Instructions

Application Instructions

Mixing

Manufacturer's Safety Data Sheets

##### SD-10 Operation and Maintenance Data

Coatings, Data Package 1;

\*\*\*\*\*Amendment 0003

#### 1.5 QUALITY ASSURANCE

##### 1.5.1 Regulatory Requirements

##### 1.5.1.1 Environmental Protection

In addition to requirements specified elsewhere for environmental protection, provide coating materials that conform to the restrictions of the local Air Pollution Control District and regional jurisdiction. Notify

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Contracting Officer of any paint specified herein which fails to conform.

1.5.1.2 Lead Content

Do not use coatings having a lead content over 0.06 percent by weight of nonvolatile content.

1.5.1.3 Chromate Content

Do not use coatings containing zinc-chromate or strontium-chromate.

1.5.1.4 Asbestos Content

Provide asbestos-free materials.

1.5.1.5 Mercury Content

Provide materials free of mercury or mercury compounds.

1.5.1.6 Silica

Provide abrasive blast media containing no free crystalline silica.

1.5.1.7 Human Carcinogens

Provide materials that do not contain ACGIH 0100 confirmed human carcinogens (A1) or suspected human carcinogens (A2).

1.5.1.8 Carbon Based Fibers / Tubes

Materials must not contain carbon based fibers such as carbon nanotubes or carbon nanofibers. Intelligence Bulletin 65 ranks toxicity of carbon nanotubes on a par with asbestos.

1.5.2 Coating Contractor's Qualification

Submit the name, address, telephone number, and e-mail address of the Contractor that will be performing all surface preparation and coating application. 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. List information by individual and include the following:

a. Name of individual and proposed position for this work.

b. Information about each previous assignment including:

Position or responsibility

Employer (if other than the Contractor)

Name of facility owner

Mailing address and telephone number of facility owner

Name of individual in facility owner's organization who can be contacted as a reference

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Location, size and description of structure

Dates work was carried out

Description of work carried out on structure

#### 1.5.3 Approved Products List

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. Provide all coats on a particular substrate from a single manufacturer. No variation from the MPI Approved Products List is acceptable.

#### 1.5.4 Paints and Coatings Indoor Air Quality Certifications

Provide paint and coating products certified to meet indoor air quality requirements by MPI GPS-1-14, MPI GPS-2-14 or provide certification by other third-party programs. Provide current product certification documentation from certification body.

Provide certification of Indoor Air Quality for Paints and Primers. Provide certification of Indoor Air Quality for Consolidated Latex Paints. Submit required indoor air quality certifications in one submittal package.

#### 1.5.5 Field Samples and Tests

The Contracting Officer may choose up to two coatings that have been delivered to the site to be tested at no cost to the Government. Take samples of each chosen product as specified in the paragraph SAMPLING PROCEDURE. Test each chosen product as specified in the paragraph TESTING PROCEDURE. Remove products from the job site which do not conform, and replace with new products that conform to the referenced specification. Test replacement products that failed initial testing as specified in the paragraph TESTING PROCEDURE at no cost to the Government.

##### 1.5.5.1 Sampling Procedure

Select paint at random from the products that have been delivered to the job site for sample testing. The Contractor must provide one quart samples of the selected paint materials. Take samples in the presence of the Contracting Officer, and label, and identify each sample. Provide labels in accordance with the paragraph PACKAGING, LABELING, AND STORAGE.

##### 1.5.5.2 Testing Procedure

Provide Batch Quality Conformance Testing for specified products, as defined by and performed by MPI. As an alternative to Batch Quality Conformance Testing, the Contractor may provide Qualification Testing for specified products above to the appropriate MPI product specification, using the third-party laboratory approved under the paragraph QUALIFICATION TESTING laboratory for coatings. Include the backup data and summary of the test results within the qualification testing lab report. Provide a summary listing of all the reference specification requirements and the result of each test. Clearly indicate in the summary whether the tested

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paint meets each test requirement. Note that Qualification Testing may take 4 to 6 weeks to perform, due to the extent of testing required.

Submit name, address, telephone number, FAX number, and e-mail address of the independent third party laboratory selected to perform testing of coating samples for compliance with specification requirements. Submit documentation that laboratory is regularly engaged in testing of paint samples for conformance with specifications, and that employees performing testing are qualified. If MPI is chosen to perform the Batch Quality Conformance testing, the above submittal information is not required, only a letter is required from the Contractor stating that MPI will perform the testing.

**Amendment 0003\*\*\*\*\***

1.5.6 Textured Wall Coating System

**DELETED**

1.5.7 Sample Textured Wall Coating System Mock-Up

**DELETED**

**\*\*\*\*\*Amendment 0003**

1.6 PACKAGING, LABELING, AND STORAGE

Provide paints in sealed containers that legibly show the Contract specification number, designation name, formula or specification number, batch number, color, quantity, date of manufacture, manufacturer's formulation number, manufacturer's directions including any warnings and special precautions, and name and address of manufacturer. Furnish pigmented paints in containers not larger than 5 gallons. Store paints and thinners in accordance with the manufacturer's written directions, and as a minimum, stored off the ground, under cover, with sufficient ventilation to prevent the buildup of flammable vapors, and at temperatures between 40 to 95 degrees F.

1.7 SAFETY AND HEALTH

Comply with applicable Federal, State, and local laws and regulations, and with the ACCIDENT PREVENTION PLAN, including the Activity Hazard Analysis as specified in Section 01 35 26 GOVERNMENTAL SAFETY REQUIREMENTS and in Appendix A of EM 385-1-1. Include in the Activity Hazard Analysis the potential impact of painting operations on painting personnel and on others involved in and adjacent to the work zone.

1.7.1 Toxic Materials

To protect personnel from overexposure to toxic materials, conform to the most stringent guidance of:

- a. The applicable manufacturer's Safety Data Sheets (SDS) or local regulation.
- b. 29 CFR 1910.1000.
- c. ACGIH 0100, threshold limit values.

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- d. The appropriate OSHA standard in 29 CFR 1910.1025 and 29 CFR 1926.62 for surface preparation on painted surfaces containing lead. Removal and disposal of coatings which contain lead is specified in Section 02 83 00 LEAD REMEDIATION. Additional guidance is given in SSPC Guide 6 and SSPC Guide 7. Refer to drawings for list of hazardous materials located on this project. Coordinate paint preparation activities with this specification section.

Submit manufacturer's Safety Data Sheets for coatings, solvents, and other potentially hazardous materials, as defined in FED-STD-313.

## 1.8 ENVIRONMENTAL REQUIREMENTS

Comply, at minimum, with manufacturer recommendations for space ventilation during and after installation.

### 1.8.1 Coatings

Do not apply coating when air or substrate conditions are:

- a. Less than 5 degrees F above dew point;
- b. Below 50 degrees F or over 95 degrees F, unless specifically pre-approved by the Contracting Officer and the product manufacturer. Do not, under any circumstances, violate the manufacturer's application recommendations.

## PART 2 PRODUCTS

### 2.1 MATERIALS

Conform to the coating specifications and standards referenced in PART 3. Submit Product Data Sheets for specified coatings and solvents. Provide preprinted cleaning and maintenance instructions for all coating systems. Submit Manufacturer's Instructions on Mixing: Detailed mixing instructions, minimum and maximum application temperature and humidity, pot life, and curing and drying times between coats.

### 2.2 COLOR SELECTION OF FINISH COATS

Provide colors of finish coats as indicated or specified. Allow Contracting Officer to select colors not indicated or specified. Manufacturers' names and color identification are used for the purpose of color identification only. Named products are acceptable for use only if they conform to specified requirements. Products of other manufacturers are acceptable if the colors are approximately the colors indicated and the product conforms to specified requirements.

Provide color, texture, and pattern of wall coating systems in accordance with Section 09 06 00 SCHEDULES FOR FINISHES . Submit manufacturer's samples of paint colors. Cross reference color samples to color scheme as indicated. Submit color stencil codes. Tint each coat progressively darker to enable confirmation of the number of coats.

## PART 3 EXECUTION

### 3.1 PROTECTION OF AREAS AND SPACES NOT TO BE PAINTED

Prior to surface preparation and coating applications, remove, mask, or

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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, reinstall removed items by workmen skilled in the trades. Restore surfaces contaminated by coating materials, to original condition and repair damaged items.

### 3.2 REPUTTYING AND REGLAZING

Remove cracked, loose, and defective putty or glazing compound on glazed sash and provide new putty or glazing compound. Where defective putty or glazing compound constitutes 30 percent or more of the putty at any one light, remove the glass and putty or glazing compound and reset the glass. Remove putty or glazing compound without damaging sash or glass. Clean rabbets to bare wood or metal and prime prior to reglazing. Provide linseed oil putty for wood sash. Patch surfaces to provide smooth transition between existing and new surfaces. Finish putty or glazing compound to a neat and true bead. Allow glazing compound time to cure, in accordance with manufacturer's recommendation, prior to coating application. Allow putty to set one week prior to coating application.

### 3.3 RESEALING OF EXISTING EXTERIOR JOINTS

#### 3.3.1 Surface Condition

Begin with surfaces that are clean, dry to the touch, and free from frost and moisture; remove grease, oil, wax, lacquer, paint, defective backstop, or other foreign matter that would prevent or impair adhesion. Where adequate grooves have not been provided, clean out to a depth of 1/2 inch and grind to a minimum width of 1/4 inch without damage to adjoining work. Grinding is not required on metal surfaces.

#### 3.3.2 Backstops

In joints more than 1/2 inch deep, install glass fiber roving or neoprene, butyl, polyurethane, or polyethylene foams free of oil or other staining elements as recommended by sealant manufacturer. Provide backstop material compatible with sealant. Do not use oakum and other types of absorptive materials as backstops.

#### 3.3.3 Primer and Bond Breaker

Install the type recommended by the sealant manufacturer.

#### 3.3.4 Ambient Temperature

Between 38 degrees F and 95 degrees F when applying sealant.

#### 3.3.5 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. Color(s) will be selected by the Contracting Officer. Apply the sealant in accordance with the manufacturer's printed instructions. Force sealant into joints with sufficient pressure to fill the joints solidly. Apply sealant uniformly smooth and free of wrinkles.

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### 3.3.6 Cleaning

Immediately remove fresh sealant from adjacent areas using a solvent recommended by the sealant manufacturer. Upon completion of sealant application, remove remaining smears and stains and leave the work in a clean condition. Allow sealant time to cure, in accordance with manufacturer's recommendations, prior to coating.

## 3.4 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. Remove oil and grease prior to mechanical cleaning. Schedule cleaning so that dust and other contaminants will not fall on wet, newly painted surfaces. Spot-prime exposed ferrous metals such as nail heads on or in contact with surfaces to be painted with water-thinned paints, with a suitable corrosion-inhibitive primer capable of preventing flash rusting and compatible with the coating specified for the adjacent areas. Refer to MPI ASM and MPI MRM for additional more specific substrate preparation requirements.

### 3.4.1 Additional Requirements for Preparation of Surfaces With Existing Coatings

Before application of coatings, perform the following on surfaces covered by soundly-adhered coatings, defined as those which cannot be removed with a putty knife:

- a. Test existing finishes for lead before sanding, scraping, or removing. If lead is present, refer to paragraph Toxic Materials.
- b. Wipe previously painted surfaces to receive solvent-based coatings, except stucco and similarly rough surfaces clean with a clean, dry cloth saturated with mineral spirits, ASTM D235 or as specified in MPI MRM. Wipe the surfaces dry with a clean, dry, lint free cloth. Wipe immediately preceding the application of the first coat of any coating, unless specified otherwise.
- c. Sand existing glossy surfaces to be painted to reduce gloss. Brush, and wipe clean with a damp cloth to remove dust.
- d. The requirements specified are minimum. Comply also with the application instructions of the paint manufacturer and specific surface preparation requirements as outlined in MPI MRM Exterior Surface Preparation and Interior Surface Preparation.
- e. Thoroughly clean previously painted surfaces damaged during construction of all grease, dirt, dust or other foreign matter.
- f. Remove blistering, cracking, flaking and peeling or otherwise deteriorated coatings.
- g. Remove chalk so that when tested in accordance with ASTM D4214, the chalk resistance rating is no less than 8.
- h. Roughen slick surfaces. Repair damaged areas such as, but not limited to, nail holes, cracks, chips, and spalls with suitable material to match adjacent undamaged areas.

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- i. Feather and sand smooth edges of chipped paint.
- j. Clean rusty metal surfaces in accordance with SSPC requirements. Use solvent, mechanical, or chemical cleaning methods to provide surfaces suitable for painting.
- k. Provide new, proposed coatings that are compatible with existing coatings.

#### 3.4.2 Existing Coated Surfaces with Minor Defects

Sand, spackle, and treat minor defects to render them smooth. Minor defects are defined as scratches, nicks, cracks, gouges, spalls, alligatoring, chalking, and irregularities due to partial peeling of previous coatings. Remove chalking by sanding so that when tested in accordance with ASTM D4214, the chalk rating is not less than 8.

#### 3.4.3 Substrate Repair

- a. Repair substrate surface damaged during coating removal;
- b. Sand edges of adjacent soundly-adhered existing coatings so they are tapered as smooth as practical to areas involved with coating removal; and
- c. Clean and prime the substrate as specified.

### 3.5 PREPARATION OF METAL SURFACES

#### 3.5.1 Existing and New 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 2, or . Brush-off blast remaining surface in accordance with SSPC 7/NACE No.4; Protect shop-coated ferrous surfaces from corrosion by treating and touching up corroded areas immediately upon detection.
- b. Surfaces With More Than 20 Percent Rust, Mill Scale, and Other Foreign Substances: Clean entire surface in accordance with SSPC SP 6/NACE No.3 / SSPC-SP WJ-3/NACE WJ-3.

#### 3.5.2 Final Ferrous Surface Condition:

##### 3.5.2.1 Tool Cleaned Surfaces

Comply with SSPC SP 2 and SSPC SP 3. Use as a visual reference, photographs in SSPC VIS 3 for the appearance of cleaned surfaces.

##### 3.5.2.2 Abrasive Blast Cleaned Surfaces

Comply with SSPC 7/NACE No.4, SSPC SP 6/NACE No.3, and SSPC SP 10/NACE No. 2. Use as a visual reference, photographs in SSPC VIS 1 for the appearance of cleaned surfaces.

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### 3.5.2.3 Waterjet Cleaned Surfaces

Comply with SSPC-SP WJ-1/NACE WJ-1, SSPC-SP WJ-2/NACE WJ-2, SSPC-SP WJ-3/NACE WJ-3 or SSPC-SP WJ-4/NACE WJ-4. Use as a visual reference, photographs in SSPC VIS 4/NACE VIS 7 for the appearance of cleaned surfaces.

### 3.5.3 Galvanized Surfaces

- a. New or Existing Galvanized Surfaces With Only Dirt and Zinc Oxidation Products: Clean with solvent, in accordance with SSPC SP 1. Completely remove coating by brush-off abrasive blast if the galvanized metal has been passivated or stabilized. Do not "passivate" or "stabilize" new galvanized steel to be coated. 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 WJ-3/NACE WJ-3 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.
- c. Galvanized With Severe Deteriorated Coating or Severe Rusting: Spot abrasive blast rusted areas as described for steel in SSPC SP 6/NACE No.3, and waterjet to SSPC-SP WJ-3/NACE WJ-3 to remove existing coating.

### 3.5.4 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.

### 3.5.5 Terne-Coated Metal Surfaces

Solvent clean surfaces with mineral spirits, ASTM D235. Wipe dry with clean, dry cloths.

### 3.5.6 Existing Surfaces with a Bituminous or Mastic-Type Coating

Remove chalk, mildew, and other loose material by washing with a solution of 1/2 cup trisodium phosphate, 1/4 cup household detergent, one quart 5 percent sodium hypochlorite solution and 3 quarts of warm water.

## 3.6 PREPARATION OF CONCRETE AND CEMENTITIOUS SURFACE

### 3.6.1 Concrete and Masonry

- a. Curing: Allow concrete, stucco and masonry surfaces to cure at least 30 days before painting, and concrete slab on grade to cure at least 90 days before painting.
- b. Surface Cleaning: Remove the following deleterious substances.
  - (1) Dirt, Chalking, Grease, and Oil: Wash new and existing uncoated

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surfaces with a solution composed of 1/2 cup trisodium phosphate, 1/4 cup household detergent, and 4 quarts of warm water. Then rinse thoroughly with fresh water. Wash existing coated surfaces with a suitable detergent and rinse thoroughly. 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, one quart 5 percent sodium hypochlorite solution and 3 quarts of warm water. Rinse thoroughly with fresh water.

(3) Paint and Loose Particles: Remove by wire brushing.

(4) Efflorescence: Remove by scraping or wire brushing followed by washing with a 5 to 10 percent by weight aqueous solution of hydrochloric (muriatic) acid. Do not allow acid to remain on the surface for more than five minutes before rinsing with fresh water. Do not acid clean more than 4 square feet of surface, per workman, at one time.

- c. Cosmetic Repair of Minor Defects: Repair or fill mortar joints and minor defects, including but not limited to spalls, in accordance with manufacturer's recommendations and prior to coating application.
- d. 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 manufacturer's recommendations. Allow surfaces to cure a minimum of 30 days before painting.

### 3.6.2 Gypsum Board, Plaster, and Stucco

#### 3.6.2.1 Surface Cleaning

Verify that plaster and stucco surfaces are free from loose matter and that gypsum board is 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 is water-based.

#### 3.6.2.2 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.

#### 3.6.2.3 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. Verify that new plaster to be coated has 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.

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### 3.7 APPLICATION

#### 3.7.1 Coating Application

- a. Comply with applicable federal, state and local laws enacted to ensure 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.
- b. At the time of application, paint must show no signs of deterioration. Maintain uniform suspension of pigments during application.
- c. 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. Use rollers for applying paints and enamels 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.
- d. Only apply paints, except water-thinned types, to surfaces that are completely free of moisture as determined by sight or touch.
- e. Thoroughly work coating materials into joints, crevices, and open spaces. Pay special attention to ensure that all edges, corners, crevices, welds, and rivets receive a film thickness equal to that of adjacent painted surfaces.
- f. Apply each coat of paint so that dry film is of uniform thickness and free from runs, drops, ridges, waves, pinholes or other voids, laps, brush marks, and variations in color, texture, and finish. Completely hide all blemishes.
- g. Touch up damaged coatings before applying subsequent coats. Broom clean and clear dust from interior areas before and during the application of coating material.
- m. 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.
- n. 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. Cover each preceding coat or surface completely by ensuring visually perceptible difference in shades of successive coats.
- o. Finished Surfaces: Provide finished surfaces free from runs, drops, ridges, waves, laps, brush marks, and variations in colors.
- p. Thermosetting Paints: Apply topcoats over thermosetting paints (epoxies and urethanes) within the overcoat window recommended by the manufacturer.
- q. Floors:

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### 3.7.2 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. Verify that the written permission includes quantities and types of thinners to use.

When thinning is allowed, thin paints immediately prior to application with not more than one pint of suitable thinner per gallon. The use of thinner does not relieve the Contractor from obtaining complete hiding, full film thickness, or required gloss. Thinning cannot cause the paint to exceed limits on volatile organic compounds. Do not mix paints of different manufacturers.

### 3.7.3 Two-Component Systems

Mix two-component systems in accordance with manufacturer's instructions. Follow recommendation by the manufacturer for any thinning of the first coat to ensure proper penetration and sealing for each type of substrate.

### 3.7.4 Coating Systems

- a. Systems by Substrates: Apply coatings that conform to the respective specifications listed in the following Tables:

| Table for Exterior Applications |                                                                        |
|---------------------------------|------------------------------------------------------------------------|
| MPI Division                    | Substrate Application                                                  |
| MPI Division 3                  | Exterior Concrete Paint Table                                          |
| MPI Division 4                  | Exterior Concrete Masonry Units Paint Table                            |
| MPI Division 5                  | Exterior Metal, Ferrous and Non-Ferrous Paint Table                    |
| MPI Division 6                  | Exterior Wood; Dressed Lumber, Paneling, Decking, Shingles Paint Table |
| MPI Division 9                  | Exterior Stucco Paint Table                                            |
| MPI Division 10                 | Exterior Cloth Coverings and Bituminous Coated Surfaces Paint Table    |

| Table for Interior Applications |                                                     |
|---------------------------------|-----------------------------------------------------|
| MPI Division                    | Substrate Application                               |
| MPI Division 3                  | Interior Concrete Paint Table                       |
| MPI Division 4                  | Interior Concrete Masonry Units Paint Table         |
| MPI Division 5                  | Interior Metal, Ferrous and Non-Ferrous Paint Table |

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| Table for Interior Applications |                                                                  |
|---------------------------------|------------------------------------------------------------------|
| MPI Division 6                  | Interior Wood Paint Table                                        |
| MPI Division 9                  | Interior Plaster, Gypsum Board,<br>Textured 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 unspecified surfaces the same as surfaces having similar conditions of exposure.
- d. Existing Surfaces Damaged During Performance of the Work, Including New Patches In Existing Surfaces: Coat surfaces with the following:
  - (1) One coat of primer.
  - (2) One coat of undercoat or intermediate coat.
  - (3) One topcoat to match adjacent surfaces.
- e. Existing Coated Surfaces To Be Painted: Apply coatings conforming to the respective specifications listed in the Tables herein, except that pretreatments, sealers and fillers need not be provided on surfaces where existing coatings are soundly adhered and in good condition. Do not omit undercoats or primers.

### 3.8 COATING SYSTEMS FOR METAL

Apply coatings of Tables in MPI Division 5 for Exterior and Interior.

- a. Apply specified ferrous metal primer to steel surfaces 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. Overcoat these items 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.

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### 3.9 COATING SYSTEMS FOR CONCRETE AND CEMENTITIOUS SUBSTRATES

Apply coatings of Tables in MPI Division 3, 4 and 9 for Exterior and Interior.

### 3.10 COATING SYSTEMS FOR WOOD AND PLYWOOD

- a. Apply coatings of Tables in MPI Division 6 for Exterior and Interior.
- b. Prior to erection, apply two coats of specified primer to treat and prime wood and plywood surfaces which will be inaccessible after erection.
- c. Apply stains in accordance with manufacturer's printed instructions.

### 3.11 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. Perform this demonstration after appropriate curing and drying times of coatings have elapsed and prior to invoicing for final payment.

### 3.12 WASTE MANAGEMENT

As specified in the Waste Management Plan and as follows. Do not use kerosene or any such organic solvents to clean up water based paints. Properly dispose of paints or solvents in designated containers. Close and seal partially used containers of paint to maintain quality as necessary for reuse. Store in protected, well-ventilated, fire-safe area at moderate temperature. Place materials defined as hazardous or toxic waste in designated containers. Coordinate with manufacturer for take-back program. Set aside scrap to be returned to manufacturer for recycling into new product. When such a service is not available, contact local recyclers to reclaim the materials. Set aside extra paint for future color matches or reuse by the Government. Where local options exist for leftover paint recycling, collect all waste paint by type and provide for delivery to recycling or collection facility for reuse by local organizations.

### 3.13 PAINT TABLES

All DFT's are minimum values. Acceptable products are listed in the MPI Green Approved Products List, available at <https://www.mpi.net/APL/index.asp>.

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#### 3.13.1 Exterior Paint Tables 3.13.1.1 MPI Division 5: Exterior Metal, Ferrous and Non-Ferrous Paint Table

- A. Exterior Galvanized Surfaces
  - (1) New Galvanized surfaces

| Waterborne Primer / Latex |        |              |         |            |
|---------------------------|--------|--------------|---------|------------|
| New Galvanized Surfaces   | Primer | Intermediate | Topcoat | System DFT |

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|                                              |         |         |         |          |
|----------------------------------------------|---------|---------|---------|----------|
| MPI EXT<br>5.3H-G6 (Gloss)                   | MPI 134 | MPI 119 | MPI 119 | 4.5 mils |
| Topcoat: Coating to match adjacent surfaces. |         |         |         |          |

### 3.13.2 Interior Paint Tables

#### 3.13.2.1 MPI Division 3: Interior Concrete Paint Table

A. New and uncoated existing and Existing, previously painted Concrete, vertical surfaces, not specified otherwise

| Latex                                        |                                    |        |              |         |            |
|----------------------------------------------|------------------------------------|--------|--------------|---------|------------|
| New, uncoated<br>Existing                    | Existing,<br>previously<br>painted | Primer | Intermediate | Topcoat | System DFT |
| MPI INT<br>3.1A-G2 (Flat)                    | MPI RIN 3.1A-G2<br>(Flat)          | MPI 3  | MPI 44       | MPI 44  | 4 mils     |
| MPI INT<br>3.1A-G3<br>(Eggshell)             | MPI RIN 3.1A-G3<br>(Eggshell)      | MPI 3  | MPI 52       | MPI 52  | 4 mils     |
| MPI INT 3.1A-G5                              | MPI RIN 3.1A-G5<br>(Semigloss)     | MPI 3  | MPI 54       | MPI 54  | 4 mils     |
| Topcoat: Coating to match adjacent surfaces. |                                    |        |              |         |            |

C. New and uncoated existing and Existing, previously painted Concrete in restrooms, shower areas, and other high-humidity areas not otherwise specified except floors

| Epoxy                                                          |                                    |        |              |         |            |
|----------------------------------------------------------------|------------------------------------|--------|--------------|---------|------------|
| New, uncoated<br>Existing                                      | Existing,<br>previously<br>painted | Primer | Intermediate | Topcoat | System DFT |
| MPI INT<br>3.1F-G6 (Gloss)                                     | MPI RIN 3.1E-G6<br>(Gloss)         | MPI 77 | MPI 77       | MPI 77  | 4 mils     |
| Note: Primer may be reduced for penetration per manufacturer's |                                    |        |              |         |            |

D. New and uncoated existing and Existing, previously painted concrete walls and bottom of swimming pools

| Epoxy                     |                                    |        |              |         |            |
|---------------------------|------------------------------------|--------|--------------|---------|------------|
| New, uncoated<br>Existing | Existing,<br>previously<br>painted | Primer | Intermediate | Topcoat | System DFT |

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|                                                                              |              |        |        |        |        |
|------------------------------------------------------------------------------|--------------|--------|--------|--------|--------|
| MPI INT 3.1F                                                                 | MPI RIN 3.1E | MPI 77 | MPI 77 | MPI 77 | 4 mils |
| Note: Primer may be reduced for penetration per manufacturer's instructions. |              |        |        |        |        |

### 3.13.2.2 MPI Division 4: Interior Concrete Masonry Units Paint Table

#### A. New and uncoated Existing Concrete Masonry

| High Performance Architectural Latex |        |        |              |         |            |
|--------------------------------------|--------|--------|--------------|---------|------------|
| New, uncoated<br>Existing            | Filler | Primer | Intermediate | Topcoat | System DFT |
| MPI INT<br>4.2D-G5<br>(Semigloss)    | MPI 4  | N/A    | MPI 141      | MPI 141 | 11 mils    |
| Fill all holes in masonry surface    |        |        |              |         |            |

#### B. Existing, Previously Painted Concrete Masonry

| High Performance Architectural Latex |        |         |              |         |            |
|--------------------------------------|--------|---------|--------------|---------|------------|
| Existing,<br>previously<br>painted   | Filler | Primer  | Intermediate | Topcoat | System DFT |
| MPI RIN<br>4.2K-G5<br>(Semigloss)    | N/A    | MPI 141 | MPI 141      | MPI 141 | 4.5 mils   |

#### C. New and uncoated Existing Concrete masonry units in restrooms, shower areas, and other high humidity areas unless otherwise specified

| Epoxy                             |         |        |              |         |            |
|-----------------------------------|---------|--------|--------------|---------|------------|
| New, uncoated<br>Existing         | Filler  | Primer | Intermediate | Topcoat | System DFT |
| MPI INT 4.2G-G6<br>(Gloss)        | MPI 116 | N/A    | MPI 77       | MPI 77  | 10 mils    |
| Fill all holes in masonry surface |         |        |              |         |            |

#### D. Existing, previously painted, concrete masonry units in restrooms, shower areas, and other high humidity areas unless otherwise specified

| Epoxy                           |        |        |              |         |            |
|---------------------------------|--------|--------|--------------|---------|------------|
| Existing,<br>previously painted | Filler | Primer | Intermediate | Topcoat | System DFT |
| MPI RIN 4.2D-G6                 | N/A    | MPI 77 | MPI 77       | MPI 77  | 5 mils     |

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3.13.2.3 MPI Division 9: Interior Plaster, Gypsum Board, Textured Surfaces  
Paint Table

A. Interior New and Existing, previously painted Wallboard not otherwise specified

| Latex                                        |                                    |        |              |         |            |
|----------------------------------------------|------------------------------------|--------|--------------|---------|------------|
| New                                          | Existing,<br>previously<br>painted | Primer | Intermediate | Topcoat | System DFT |
| MPI INT<br>9.2A-G2 (Flat)                    | RIN 9.2A-G2<br>(Flat)              | MPI 50 | MPI 44       | MPI 44  | 4 mils     |
| MPI INT<br>9.2A-G3<br>(Eggshell)             | RIN 9.2A-G3<br>(Eggshell)          | MPI 50 | MPI 52       | MPI 52  | 4 mils     |
| MPI INT<br>9.2A-G5<br>(Semigloss)            | RIN 9.2A-G5<br>(Semigloss)         | MPI 50 | MPI 54       | MPI 54  | 4 mils     |
| Topcoat: Coating to match adjacent surfaces. |                                    |        |              |         |            |

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-- End of Section --

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## SECTION 10 51 13

## LOCKERS

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## 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 D4976 (2012; R 2020) Standard Specification for  
Polyethylene Plastics Molding and  
Extrusion Materials

## U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS AA-L-00486 (Rev J) Lockers, Clothing, Steel

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

36 CFR 1191 Americans with Disabilities Act (ADA)  
Accessibility Guidelines for Buildings and  
Facilities; Architectural Barriers Act  
(ABA) Accessibility Guidelines

## 1.2 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

## SD-02 Shop Drawings

Types;

Location;

Installation

Numbering System

## SD-03 Product Data

Material

Locking Devices

Handles

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Finish

Locker Components

Assembly Instructions

SD-04 Samples

Color Chips;

### 1.3 DELIVERY, HANDLING, AND STORAGE

Deliver lockers and associated materials in their original packages, containers, or bundles bearing the manufacturer's name and the name of the material. Protect from weather, soil, and damage during delivery, storage, and construction.

### 1.4 FIELD MEASUREMENTS

To ensure proper fits, make field measurements prior to the preparation of drawings and fabrication. Verify correct location.

### 1.5 QUALITY ASSURANCE

#### 1.5.1 Color Chips

Provide a minimum of three color chips, not less than 3 inches square, of each color as requested by Contracting Officer..

Government may request performance-characteristic tests on assembled lockers. Tests and results must conform to FS AA-L-00486. Tests and results for HDPE lockers must conform to applicable requirements of ASTM D4976 and applicable requirements of FS AA-L-00486. Lockers not conforming will be rejected.

## PART 2 PRODUCTS

### 2.1 ACCESSIBILITY

Comply with 36 CFR 1191 with regard to accessibility of lockers and locker benches, locker features, latching and locking, and signage.

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### 2.2 TYPES

Locker must have the following type and size in the location and quantities indicated **on elevations provided**. Locker finish colors will be selected from manufacturer's standard colors by Contracting Officer through the submittal process..

Lockers must be manufactured as prefabricated solid high-density polyethylene (HDPE) units.

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#### 2.2.1 Single-tier Lockers

Single-tier lockers must be as follows:

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Type EQ-01: Single-tier locker 15 inches wide, 24 inches deep, and 72 inches high, attached to concrete base and bench as per drawings

#### 2.2.2 Double-tier Z-style Lockers

Double-tier Z-style lockers must be as follows:

Type EQ-02: Double-tier Z-style locker 15 inches wide, 24 inches deep, and 60 inches high, attached to concrete base and bench as per drawings.

#### 2.2.3 Three-tier Lockers

Three-tier lockers must be as follows:

Type EQ-03: Three-tier locker 15 inches wide, 24 inches deep, and 72 inches high, attached to concrete base and bench as per drawings

#### 2.2.4 Four-tier Lockers

Four-tier lockers must be as follows:

Type EQ-04: Four-tier locker 15 inches wide, 24 inches deep, and 72 inches high, attached to concrete base and bench as per drawings

### 2.3 MATERIAL

#### 2.3.1 Solid High-Density Polyethylene (HDPE)

ASTM D4976 solid 1/2 inch HDPE panels, extrusions, and casting forming locker bodies, doors, and shelves. Include bases, sloped tops, end panels, and infill panels.

#### 2.3.2 Finish

##### 2.3.2.1 Color

As selected from manufacturer's Standard Colors by Contracting Officer through the Submittal Process..

### 2.4 COMPONENTS

#### 2.4.1 Built-In Locks

Built-in locks are not required.

#### 2.4.2 Coat Hooks

FS AA-L-00486, stainless steel.

#### 2.4.3 Hanger Rods

FS AA-L-00486, chromium plated steel.

#### 2.4.4 Door Handles

FS AA-L-00486. Provide stainless steel handles.

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2.4.5 Doors

FS AA-L-00486, **solid HDPE doors**. Provide partial louvered face providing a minimum 010 percent open area.

2.4.5.1 Hinges

In addition to the requirements of FS AA-L-00486, provide 5-knuckle hinges, minimum 2 inches high. Fabricate knuckle hinges from **solid HDPE**. Weld, bolt, or rivet hinges to the door to suit materials.

2.4.5.2 Latching Mechanisms

FS AA-L-00486.

2.4.6 Latch Strikes

FS AA-L-00486. Fabricate from **solid HDPE**, except latch strike must be continuous from top to bottom and fabricated as part of the door framing. Provide no less than two silencers per door strike.

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2.4.7 Solid HDPE Latches

Provide recessed door latch assembly of solid HDPE with latching devices compatible with the locker body construction. Include necessary metal components to provide latching and locking function with latches engaging the locker body at two locations for double tier doors and three locations for single tier full height doors.

2.4.8 Silencers

FS AA-L-00486.

2.4.9 Back and Side Panels, Tops, and Bottoms

FS AA-L-00486, not less than 1/2 inch solid HDPE panel. Provide concealed anchored filler pieces where indicated that match side panel material.

2.4.10 Sloping Locker Tops

Provide sloping locker tops in addition to the locker-section flat tops. Sloping tops must be continuous in length. Provide fillers or closures at the exposed end of sloping tops. Fabricate sloping tops from not less than 3/8 inch solid HDPE panels.

2.4.11 Shelves

FS AA-L-00486. Fabricate from not less than 1/2 inch solid HDPE panels.

2.4.12 Number Plates

FS AA-L-00486. Aluminum. Provide consecutive numbers from 000 to 999.

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#### 2.4.13 Locker Benches

Provide fixed locker benches as manufactured by the locker manufacturer. Match materials and finishes of bench tops to lockers. Provide stainless steel anchor types suited to the floor substrate designed to transfer full support and stability loads to the substrates.

#### 2.4.14 Locker Bench Tops

Support bench tops with welded metal tube pedestals or welded metal wall brackets with a minimum of two support points for each bench length. Maximum length 72 inches. Height from finished floor to top of bench 17-1/2 inches. Fabricate pedestal and wall brackets from stainless steel. Provide stainless steel fasteners and anchors. Space support points for each bench as required to support 100 plf with maximum deflection not to exceed L/180 between supports.

Provide bench tops fabricated from 1-1/4 inch thick solid HDPE with textured finish. With top width of 9-1/2 inches. Provide bench dimensions required for accessibility compliance.

#### 2.4.15 Fastening Devices

Provide bolts, nuts, and rivets as specified in FS AA-L-00486.

### PART 3 EXECUTION

#### 3.1 ASSEMBLY AND INSTALLATION

Assemble lockers according to the locker manufacturer's instructions. Align lockers horizontally and vertically. Secure lockers to wall with screws as indicated. Bolt adjacent lockers together. Adjust doors to operate freely without sticking or binding and to ensure they close tightly.

#### 3.2 FIELD QUALITY CONTROL

##### 3.2.1 Testing

Government may request performance-characteristic tests on assembled lockers in accordance with FS AA-L-00486. Lockers not conforming will be rejected.

##### 3.2.2 Repairing

Remove and replace damaged and unacceptable portions of completed work with new.

##### 3.2.3 Cleaning

Clean surfaces of the work, and adjacent surfaces soiled as a result of the work, in an approved manner. Remove equipment, surplus materials, and rubbish from the site.

-- End of Section --

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## SECTION 23 09 23.02

### BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS 08/24 Amendment 0003

#### PART 1 GENERAL

##### 1.1 SUMMARY

Provide a complete Direct Digital Control (DDC) system, except for the front end which is specified in Section 25 10 10 UTILITY MONITORING AND CONTROL (UMCS) FRONT END AND INTEGRATION, suitable for the control of the heating, ventilating and air conditioning (HVAC) and other building-level systems as specified and shown and in accordance with Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

#### **AMENDMENT 0003**\*\*\*\*\*

##### 1.1.1 System Requirements

Provide a system meeting the requirements of both Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC and this Section and with the following characteristics:

- a. Except for Gateways, the control system must be an open implementation of BACnet technology using ASHRAE 135 and Fox as the communications protocols. The system must use standard ASHRAE 135 Objects and Properties **DELETED**. The system must use standard ASHRAE 135 Services **DELETED** exclusively for communication over the network. Gateways to packaged units must communicate with other DDC hardware using ASHRAE 135 or the Fox protocol exclusively and may communicate with packaged equipment using other protocols. The control system must be installed such that any two ASHRAE 135 devices on the Internetwork can communicate using standard ASHRAE 135 Services.

Except for Gateways, the control system must be an open implementation of BACnet technology using ASHRAE 135 as the communications protocol. The system must use standard ASHRAE 135 Objects and Properties. The system must use standard ASHRAE 135 Services exclusively for communication over the network. Gateways to packaged units must communicate with other DDC hardware using ASHRAE 135 exclusively and may communicate with packaged equipment using other protocols. The control system must be installed such that any two devices on the Internetwork can communicate using standard ASHRAE 135 Services.

- b. Install and configure control hardware to provide ASHRAE 135 Objects and Properties **DELETED** as indicated and as needed to meet the requirements of this specification.

##### c. **DELETED**

##### d. **DELETED**

#### \*\*\*\*\*AMENDMENT 0003

##### 1.1.2 Verification of Specification Requirements

Review all specifications related to the control system installation and advise the Contracting Officer of any discrepancies before performing any

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work. If Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC or any other Section referenced in this specification is not included in the project specifications advise the Contracting Officer and either obtain the missing Section or obtain Contracting Officer approval before performing any work.

## 1.2 REFERENCES

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

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

ASHRAE 135 (2020; Interpretation 1-8 2021; Errata 1-2 2021; Addenda CD 2021; Addenda BV-CE 2022; Interpretation 9-12 2022; Interpretation 13-24 2023; Addenda BV-CF 2023; Errata 3 2023) BACnet—A Data Communication Protocol for Building Automation and Control Networks

### BACNET TESTING LABORATORIES (BTL)

BTL Guide (v.50; 2022) BACnet Testing Laboratory Implementation Guidelines

### INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 802.3 (2022; CORR 2024) Ethernet

### TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA-485 (1998a; R 2012) Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems

### U.S. FEDERAL COMMUNICATIONS COMMISSION (FCC)

FCC Part 15 Radio Frequency Devices (47 CFR 15)

### UL SOLUTIONS (UL)

UL 916 (2015; Reprint Oct 2021) UL Standard for Safety Energy Management Equipment

## 1.3 DEFINITIONS

For definitions related to this section, see Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

## 1.4 SUBMITTALS

Submittal requirements related to this Section are specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

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## PART 2 PRODUCTS

All products used to meet this specification must meet the indicated requirements, but not all products specified here will be required by every project. All products must meet the requirements of Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC, Section 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS and this Section.

### 2.1 NETWORK HARDWARE

**AMENDMENT 0003**\*\*\*\*\*

#### 2.1.1 BACnet Router

All BACnet Routers must be BACnet/IP Routers and must perform layer 3 routing of ASHRAE 135 packets over an IP network in accordance with ASHRAE 135 Annex J and Clause 6. The router must provide the appropriate connection to the IP network and connections to one or more ASHRAE 135 MS/TP networks. Devices used as BACnet Routers must meet the requirements for DDC Hardware, and devices used as BACnet routers must support the NM-RC-B BIBB.

#### 2.1.2 BACnet Gateways

In addition to the requirements for DDC Hardware, the BACnet Gateway must meet the following requirements:

- a. It must perform bi-directional protocol translation from one non-ASHRAE 135 protocol to ASHRAE 135. BACnet Gateways must incorporate a network connection to an ASHRAE 135 network (either BACnet over IP in accordance with Annex J or MS/TP) and a separate connection appropriate for the non-ASHRAE 135 protocol and media.
- b. It must retain its configuration after a power loss of an indefinite time, and must automatically return to their pre-power loss state once power is restored.
- c. It must allow bi-directional mapping of data between the non-ASHRAE 135 protocol and Standard Objects as defined in ASHRAE 135. It must support the DS-RP-B BIBB for Objects requiring read access and the DS-WP-B BIBB for Objects requiring write access.
- d. It must support the DS-COV-B BIBB.

Although Gateways must meet DDC Hardware requirements they are not DDC Hardware and must not be used when DDC Hardware is required.

\*\*\*\*\***AMENDMENT 0003**

#### 2.1.3 Ethernet Switch

Ethernet Switches must be as specified in Section 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS

### 2.2 CONTROL NETWORK WIRING

- a. BACnet MS/TP communications wiring must be in accordance with ASHRAE 135. The wiring must use shielded, three wire (twisted-pair with reference) cable with characteristic impedance between 100 and 120 ohms. Distributed capacitance between conductors must be less than 30 pF per foot.

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- b. Building Control Network Backbone IP Network must use Ethernet media. Ethernet cables must be CAT-5e at a minimum and meet all requirements of IEEE 802.3 .

## 2.3 DIRECT DIGITAL CONTROL (DDC) HARDWARE

**AMENDMENT 0003\*\*\*\*\***

### 2.3.1 General Requirements

All DDC Hardware must meet the following requirements:

- a. It must be locally powered and must incorporate a light to indicate the device is receiving power.
- b. It must conform to the BTL Guide
- c. It must be BACnet Testing Laboratory (BTL) Listed.
- d. The Manufacturer's Product Data submittal for each piece of DDC Hardware must include the Protocol Implementation Conformance Statement (PICS) for that hardware as specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.
- e. It must communicate and be interoperable in accordance with ASHRAE 135 and have connections for BACnet IP or MS/TP control network wiring.
- f. Other than devices controlling terminal units or functioning solely as a BACnet Router, it must support DS-COV-B, DS-RPM-A and DS-RPM-B BIBBs.
- g. Devices supporting the DS-RP-A BIBB must also support the DS-COV-A BIBB.
- h. Application programs, configuration settings and communication information must be stored in a manner such that they persist through loss of power:
  - (1) Application programs must persist regardless of the length of time power is lost.
  - (2) Configured settings must persist for any loss of power less than 2,500 hours.
  - (3) Communication information, including but not limited to COV subscriptions, event reporting destinations, Notification Class Object settings, and internal communication settings, must persist for any loss of power less than 2,500 hours.
- i. Internal Clocks:
  - (1) Clocks in DDC Hardware incorporating a Clock must continue to function for 120 hours upon loss of power to the DDC Hardware.
  - (2) DDC Hardware incorporating a Clock must support the DM-TS-B or DM-UTC-B BIBB.
- j. It must have all functionality indicated and required to support the application (Sequence of Operation or portion thereof) in which it is used, including but not limited to providing Objects **DELETED** as specified and as indicated on the Points Schedule.

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- k. In addition to these general requirements and the DDC Hardware Input-Output (I/O) Function requirements, all DDC Hardware must also meet any additional requirements for the application in which it is used (e.g. scheduling, alarming, trending, etc.).
- l. It must meet FCC Part 15 requirements and have UL 916 or equivalent safety listing.
- m. **DELETED** Device must support Commandable Objects to support Override requirements as detailed in PART 3 EXECUTION
- n. User interfaces which allow for modification of Properties or settings must be password-protected.
- o. Devices communicating BACnet MS/TP must meet the following requirements:
  - (1) Must have a configurable Max\_Master Property.
  - (2) DDC Hardware other than hardware controlling a single terminal unit must have a configurable Max\_Info\_Frames Property.
  - (3) Must respond to any valid request within 50 msec with either the appropriate response or with a response of "Reply Postponed".
  - (4) Must use twisted pair with reference and shield (3-wire media) wiring, or twisted pair with shield (2-wire media) wiring and use half-wave rectification.
- p. Devices communicating BACnet/IP must use UDP Port 0xBAC0. Devices with configurable UDP Ports must default to 0xBAC0.
- q. All Device IDs, Network Numbers, and BACnet MAC addresses of devices must be fully configurable without limitation, except MS/TP MAC addresses may be limited by ASHRAE 135 requirements.
- r. **DELETED** DDC Hardware controlling a single terminal unit must have:
  - (1) Objects (including the Device Object) with an Object Name Property of at least 8 characters in length.
  - (2) A configurable Device Object Name.
  - (3) A configurable Device Object Description Property at least 16 characters in length.
- s. Except for Objects in **DELETED** DDC Hardware controlling a single terminal unit, all Objects (including Device Objects) must:
  - (1) Have a configurable Object Name Property of at least 12 characters in length.
  - (2) Have a configurable Object Description Property of at least 24 characters in length.
- t. For programmable DDC Hardware, provide and license to the project site all programming software required to program the Hardware in accordance with Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

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- u. For programmable DDC Hardware, provide copies of the installed application programs (all software that is not common to every controller of the same manufacturer and model) as source code compatible with the supplied programming software in accordance with Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC. The submitted application program must be the complete application necessary for controller to function as installed and be sufficient to allow replacement of the installed controller with another controller of the same type.

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## 2.3.2 Hardware Input-Output (I/O) Functions

DDC Hardware incorporating hardware input-output (I/O) functions must meet the following requirements:

### 2.3.2.1 Analog Inputs

DC Hardware analog inputs (AIs) must be implemented using ASHRAE 135 Analog Input Objects and perform analog to digital (A-to-D) conversion with a minimum resolution of 8 bits plus sign or better as needed to meet the accuracy requirements specified in Section 23 09 00. Signal conditioning including transient rejection must be provided for each analog input. Analog inputs must be capable of being individually calibrated for zero and span. Calibration via software scaling performed as part of point configuration is acceptable. The AI must incorporate common mode noise rejection of at least 50 dB from 0 to 100 Hz for differential inputs, and normal mode noise rejection of at least 20 dB at 60 Hz from a source impedance of 10,000 ohms.

### 2.3.2.2 Analog Outputs

DDC Hardware analog outputs (AOs) must be implemented using ASHRAE 135 Analog Output Objects and perform digital to analog (D-to-A) conversion with a minimum resolution of 8 bits plus sign, and output a signal with a range of 4-20 mA<sub>dc</sub> or 0-10 V<sub>dc</sub>. Analog outputs must be capable of being individually calibrated for zero and span. Calibration via software scaling performed as part of point configuration is acceptable. DDC Hardware with Hand-Off-Auto (H-O-A) switches for analog outputs must provide for overriding the output through the range of 0 percent to 100 percent

### 2.3.2.3 Binary Inputs

DDC Hardware binary inputs (BIs) must be implemented using ASHRAE 135 Binary Input Objects and accept contact closures and must ignore transients of less than 5 milli-second duration. Protection against a transient 50VAC must be provided.

### 2.3.2.4 Binary Outputs

DDC Hardware binary outputs (BOs) must be implemented using ASHRAE 135 Binary Output Objects and provide relay contact closures or triac outputs for momentary and maintained operation of output devices. DDC Hardware with H-O-A switches for binary outputs must provide for overriding the output open or closed.

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#### 2.3.2.4.1 Relay Contact Closures

Closures must have a minimum duration of 0.1 second. Relays must provide at least 180V of isolation. Electromagnetic interference suppression must be provided on all output lines to limit transients to 50 Vac. Minimum contact rating must be 0.5 amperes at 24 Vac.

#### 2.3.2.4.2 Triac Outputs

Triac outputs must provide at least 180 V of isolation. Minimum contact rating must be 0.5 amperes at 24 Vac.

#### 2.3.2.5 Pulse Accumulator

DDC Hardware pulse accumulators must be implemented using either an ASHRAE 135 Accumulator Object or an ASHRAE 135 Analog Value Object where the Present\_Value is the totalized pulse count. Pulse accumulators must accept contact closures, ignore transients less than 5 msec duration, protect against transients of 50 VAC, and accept rates of at least 20 pulses per second.

#### 2.3.2.6 ASHRAE 135 Objects for Hardware Inputs and Outputs

The requirements for use of ASHRAE 135 objects for hardware input and outputs includes devices where the hardware sensor or actuator is integral to the controller (e.g. a VAV box with integral damper actuator, a smart sensor, a VFD, etc.)

**AMENDMENT 0003**\*\*\*\*\*

#### 2.3.2.7 Integrated H-O-A Switches

Where integrated H-O-A switches are provided on hardware outputs, controller must provide means of monitoring position or status of H-O-A switch. This feedback may be provided via **DELETED** any valid BACnet method, including the use of proprietary Objects, Properties, or Services.

#### 2.3.3 Local Display Panel (LDP)

The Local Display Panels (LDPs) must be DDC Hardware with a display and navigation buttons or a touch screen display, and must provide display and adjustment of **DELETED** ASHRAE 135 Properties as indicated on the Points Schedule and as specified. LDPs must be either BTL Listed as a B-OD, B-OWS, B-AWS, or be an integral part of another piece of DDC Hardware listed as a B-BC. For LDPs listed as B-OWS or B-AWS, the hardware must be BTL listed and the product must come factory installed with all applications necessary for the device to function as an LDP.

The adjustment of values using display and navigation buttons must be password protected.

\*\*\*\*\***AMENDMENT 0003**

#### 2.3.4 Expansion Modules and Tethered Hardware

A single piece of DDC Hardware may consist of a base unit and also:

- a. An unlimited number of hardware expansion modules, where the individual hardware expansion modules are designed to directly connect, both mechanically and electrically, to the base unit hardware. The expansion modules must be commercially available as an optional add-on to the base unit.

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- b. A single piece of hardware connected (tethered) to a base unit by a single cable where the cable carries a proprietary protocol between the base unit and tethered hardware. The tethered hardware must not contain control logic and be commercially available as an optional add-on to the base unit as a single package.

Note that this restriction on tethered hardware does not apply to sensors or actuators using standard binary or analog signals (not a communications protocol); sensors or actuators using standard binary or analog signals are not considered part of the DDC Hardware.

Hardware capable of being installed stand-alone, or without a separate base unit, is DDC Hardware and must not be used as expansion modules or tethered hardware.

### 2.3.5 Supervisory Control Requirements

#### 2.3.5.1 Scheduling Hardware

DDC Hardware used for scheduling must meet the following requirements:

- a. It must be BTL Listed as a B-BC and support the SCHED-E-B BIBB.
- b. It is preferred, but not required, that devices support the DM-OCD-B BIBB on all Calendar and Schedule Objects, such that a front end BTL listed as a B-AWS may create or delete Calendar and Schedule Objects. It is also preferred but not required that devices supporting the DM-OCD-B BIBB accept any valid value for properties of Calendar and Schedule Objects. Note that there are additional requirements in the EXECUTION Part of this Section for Devices which do not support the DM-OCD-B BIBB as specified.
- c. The Date\_List property of all Calendar Objects must be writable.
- d. The Present\_Value Property of Schedule must support the following values: 1, 2, 3, 4.

#### 2.3.5.2 Alarm Generation Hardware

DDC Hardware used for alarm generation must meet the following requirements:

- a. Device must support the AE-N-I-B BIBB
- b. The Recipient\_List Property must be Writable for all Notification Class Objects used for alarm generation.
- c. For all Objects implementing Intrinsic Alarming, the following Properties must be Writable:
  - (1) Time\_Delay
  - (2) High\_Limit
  - (3) Low\_Limit
  - (4) Deadband
  - (5) Event\_Enable
  - (6) If the issue date of this project specification is after 1 January 2016, Time\_Delay\_Normal must be writable.
- d. It is preferred, but not required, that devices support the DM-OCD-B

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BIBB on all Notification Class Objects. It is also preferred, but not required that devices supporting the DM-OCD-B BIBB accept any valid value as an initial value for properties of Notification Class Objects.

- e. For Event Enrollment Objects used for alarm generation, the following Properties must be Writable:
  - (1) Event\_Parameters
  - (2) Event\_Enable
  - (3) If the issue date of this project specification is after 1 January 2016, Time\_Delay\_Normal must be writable.
- f. It is preferred, but not required, that devices support the DM-OCD-B BIBB on all Notification Class Objects and Event Enrollment Objects, such that a front end BTL listed as a B-AWS may create or delete Notification Class Objects and Event Enrollment Objects. It is also preferred, but not required that devices supporting the DM-OCD-B BIBB accept any valid value as an initial value for properties of Notification Class Objects and Event Enrollment Objects. Note that there are additional requirements in the EXECUTION Part of this Section for devices which do not support the DM-OCD-B BIBB as specified.
- g. Devices provided to meet the the requirements indicated under "Support for Future Alarm Generation" in the EXECUTION part of this specification must support the AE-N-E-B BIBB.

#### 2.3.5.3 Trending Hardware

DDC Hardware used for collecting trend data must meet the following requirements:

- a. Device must support Trend Log or Trend Log Multiple Objects.
- b. Device must support the T-VMT-I-B BIBB.
- c. Devices provided to meet the EXECUTION requirement for support of Future Trending must support the T-VMT-E-B BIBB.
- d. The following properties of all Trend Log or Trend Log Multiple Objects must be present and Writable:
  - Start\_Time
  - Stop\_Time
  - Log\_DeviceObjectProperty
  - Log Interval Log interval must support an interval of at least 60 minutes duration.
- e. Trend Log Objects must support using Intrinsic Reporting to send a BUFFER\_FULL event.
- f. The device must have a Notification Class Object for the BUFFER\_FULL event. The Recipient\_List Property must be Writable.
- g. Devices must support values of at least 1,000 for Buffer\_Size Properties.
- h. It is preferred, but not required, that devices support the DM-OCD-B BIBB on all Trend Log Objects, such that a front end BTL listed as a A-AWS may create or delete Trend Log Objects. It is also preferred, but not required that devices supporting the DM-OCD-B BIBB accept any

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valid value as an initial value for properties of Trend Log Objects.  
Note that there are additional EXECUTION requirements for devices  
which do not support the DM-OCD-B BIBB as specified.

**AMENDMENT 0003\*\*\*\*\***

2.3.6 **DELETED**

2.4 **DELETED**

PART 3 EXECUTION

3.1 CONTROL SYSTEM INSTALLATION

3.1.1 **DELETED**

**\*\*\*\*\*AMENDMENT 0003**

3.1.2 Building Control Network (BCN)

Install the Building Control Network (BCN) as a single BACnet Internetwork consisting of a single IP network as the BCN Backbone and zero or more BACnet MS/TP networks. Note that in some cases there may only be a single device on the BCN Backbone.

Except for the IP Network and as permitted for the non-BACnet side of Gateways, use exclusively ASHRAE 135 networks.

**AMENDMENT 0002\*\*\*\*\***

3.1.2.1 Building Control Network IP Backbone

Install IP Network Cabling in conduit. Install Ethernet Switches in lockable enclosures. Install the Building Control Network (BCN) IP Backbone such that it is available at the Facility Point of Connection (FPOC) location as indicated. When the FPOC location is a room number, provide sufficient additional media to ensure that the Building Control Network (BCN) IP Backbone can be extended to any location in the room.

Use UDP port 0xBAC0 for all BACnet traffic on the IP network. **DELETED**

3.1.2.2 BACnet MS/TP Networks

When using MS/TP, provide MS/TP networks in accordance with ASHRAE 135 and in accordance with the ASHRAE 135 figure "Mixed Devices on 3-Conductor Cable with Shield" (Figure 9-1.4 in the 2020 version of ASHRAE 135). Ground the shield at the BACnet Router and at no other point. Ground the reference wire at the BACnet Router through a 100 ohm resistor and do not ground it at any other point. In addition:

- a. Provide each segment in a doubly terminated bus topology in accordance with TIA-485.
- b. Provide each segment with 2 sets of network bias resistors in accordance with ASHRAE 135, with one set of resistors at each end of the MS/TP network.
- c. Use 3 wire (twisted pair and reference) with shield media for all MS/TP media installed inside. Use fiber optic isolation in accordance with ASHRAE 135 for all MS/TP media installed outside buildings, or between multiple buildings.
- d. For 18 AWG cable, use segments with a maximum length of 4000 ft. When using greater distances or different wire gauges comply with the

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electrical specifications of TIA-485.

- e. For each controller that does not use the reference wire provide transient suppression at the network connection of the controller if the controller itself does not incorporate transient suppression.
- f. Install no more than 32 devices on each MS/TP segment. Do not use MS/TP to MS/TP routers.
- g. Connect each MS/TP network to the BCN backbone via a **DELETED** BACnet Router.
- h. For BACnet Routers, configure the MS/TP MAC address to 0. Assign MAC Addresses to other devices consecutively beginning at 1, with no gaps.
- i. Configure the Max\_Master Property of all devices to be 31.

### 3.1.2.3 Building Control Network (BCN) Installation

Provide a building control network meeting the following requirements:

- a. Install all DDC Hardware connected to the Building Control Network.
- b. Where multiple pieces of DDC Hardware are used to execute one sequence, install all DDC Hardware executing that sequence on a single MS/TP network dedicated to that sequence.
- c. Traffic between BACnet networks must be exclusively via BACnet routers.
- d. **DELETED**

\*\*\*\*\*AMENDMENT 0003

### 3.1.3 DDC Hardware

Install all DDC Hardware that connects to an IP network in lockable enclosure. Install other DDC Hardware that is not in suspended ceilings in lockable enclosures. For all DDC hardware with a user interface, coordinate with site to determine proper passwords and configure passwords into device.

- a. Except for zone sensors (thermostats), install all Tethered Hardware within 6 feet of its base unit.
- b. Install and configure all BTL-Listed devices in a manner consistent with their BTL Listing such that the device as provided still meets all requirements necessary for its BTL Listing.
- c. Install and configure all BTL-Listed devices in a manner consistent with the BTL Device Implementation Guidelines such that the device as provided meets all those Guidelines.

#### 3.1.3.1 Device Identifiers, Network Addresses, and IP addresses

- a. Do not use any Device Identifier or Network Number already used by another BACnet system at the project site. Coordinate Device IDs and Network Numbers with the installation. The installation POC is Joe Dye .
- b. Coordinate device IP addresses with installation. The installation POC is Joe Dye.

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### 3.1.3.2 ASHRAE 135 Object Name Property and Object Description Property

Configure the Object\_Names and Object\_Descriptions properties of all ASHRAE 135 Objects (including Device Objects) as indicated on the Points Schedule (Point Name and Point Description) and as specified. At a minimum:

- a. Except for DDC Hardware controlling a single terminal unit, configure the Object\_Name and Object\_Description properties of all Objects (including Device Objects) as indicated on the Points Schedule and as specified.
- b. In DDC Hardware controlling a single terminal unit, configure the Device Object\_Name and Device Object\_Description as indicated on the Points Schedule and as specified.

When Points Schedule entries exceed the length limitations in the device, notify Joe Dye and provide recommended alternatives for approval.

**AMENDMENT 0003**\*\*\*\*\*  
3.1.3.3 **DELETED**

### 3.1.3.4 **DELETED**

\*\*\*\*\***AMENDMENT 0003**  
3.1.3.5 Hand-Off-Auto (H-O-A) Switches

Provide Hand-Off-Auto (H-O-A) switches as specified and as indicated on the Points Schedule. Provide H-O-A switches that are integral to the controller hardware, an external device co-located with (in the same enclosure as) the controller, integral to the controlled equipment, or an external device co-located with (in the same enclosure as) the controlled equipment.

- a. For H-O-A switches integral to DDC Hardware, meet the requirements specified in paragraph DIRECT DIGITAL CONTROL (DDC) HARDWARE.
- b. For external H-O-A switches used for binary outputs, provide for overriding the output open or closed.
- c. For external H-O-A switches used for analog outputs, provide for overriding through the range of 0 percent to 100 percent.

**AMENDMENT 0003**\*\*\*\*\*  
3.1.3.6 Local Display Panels

Provide LDPs to display and override values of **DELETED** ASHRAE 135 Object Properties as indicated on the Points Schedule. Install LDPs displaying points for anything other than a terminal unit in the same room as the equipment. Install LDPs displaying points for only terminal units in a mechanical room central to the group of terminal units it serves. For LDPs using WriteProperty to commandable objects to implement an override, write values with priority 9.

\*\*\*\*\***AMENDMENT 0003**  
3.1.3.7 MS/TP Slave Devices

Configure all MS/TP devices as Master devices. Do not configure any

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devices to act as slave devices.

#### 3.1.3.8 Change of Value (COV) and Read Property

- a. To the greatest extent possible, configure all devices to support the SubscribeCOV service (the DS-COV-B BIBB). At a minimum, all devices supporting the DS-RP-B BIBB, other than devices controlling only a single terminal unit, must be configured to support the DS-COV-B BIBB.
- b. Whenever supported by the server side, configure client devices to use the DS-COV-A BIBB.

#### 3.1.3.9 Engineering Units

Configure devices to use English (Inch-Pound) engineering units as follows:

- a. Temperature in degrees F
- b. Air or natural gas flows in cubic feet per minute (CFM)
- c. Water in gallons per minute (GPM)
- d. Steam flow in pounds per hour (pph)
- e. Differential Air pressures in inches of water column (IWC)
- f. Water, steam, and natural gas pressures in PSI
- g. Enthalpy in BTU/lb
- h. Heating and cooling energy in MBTU (1MBTU = 1,000,000 BTU)
- i. Cooling load in tons (1 ton = 12,000 BTU/hour)
- j. Heating load in MBTU/hour (1MBTU = 1,000,000 BTU)
- k. Electrical Power: kilowatts (kW)
- l. Electrical Energy: kilowatt-hours (kWh)

#### 3.1.3.10 Occupancy Modes

Use the following correspondence between value and occupancy mode whenever an occupancy state or value is required:

- a. OCCUPIED mode: a value of one
- b. UNOCCUPIED mode: a value of two
- c. WARM-UP/COOL-DOWN (PRE-OCCUPANCY) mode: a value of three

Note that elsewhere in this Section the Schedule Object is required to also support a value of four, which is reserved for future use. Also note that the behavior of a system in each of these occupancy modes is indicated in the sequence of operation for the system.

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#### 3.1.3.11 Use of BACnet Objects

**DELETED** Use only standard non-proprietary ASHRAE 135 Objects and services to accomplish the project scope of work as follows:

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- a. Use Analog Input or Analog Output Objects for all analog hardware I/O. Do not use Analog Value Object for analog hardware I/O) .
- b. Use Binary Input or Binary Output Objects for all binary hardware I/O. Do not use Binary Value Objects for binary hardware I/O.
- c. Use Analog Value Objects for analog setpoints.
- d. Use Accumulator Objects or Analog Value Objects for pulse inputs.
- e. For occupancy modes, use Multistate Value Objects and the correspondence between value and occupancy mode specified in paragraph OCCUPANCY MODES.
- f. **DELETED**
- g. **DELETED**
- h. For all other points shown on the Points Schedule as requiring an ASHRAE 135 Object, use the Object type shown on the Points Schedule or, if no Object Type is shown, use a standard Object appropriate to the point.

#### 3.1.3.11.1 **DELETED**

\*\*\*\*\*AMENDMENT 0003

#### 3.1.3.12 Use of Standard BACnet Services

Except as noted in this paragraph, for all DDC Hardware use Standard BACnet Services as defined in this specification (which excludes some ASHRAE 135 services) exclusively for application control functionality and communication.

DDC Hardware that cannot meet this requirement may use non-standard services provided they can provide identical functionality using Standard BACnet Services when communicating with BACnet devices from a different vendor. When implementing non-standard services, document all non-standard services in the DDC Hardware Schedule as specified and as specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

**AMENDMENT 0003\*\*\*\*\***

#### 3.1.3.13 Device Application Configuration

- a. For every property, setting or value shown on the Points Schedule or otherwise indicated as Configurable, provide a value that is retained through loss of power and can be changed via one or more of:
  - (1) BACnet services (including proprietary services)
  - (2) Hardware settings on the device
  - (3) **DELETED**
- b. For every property, setting or value **DELETED** shown on the Points Schedule or otherwise indicated as Operator Configurable, provide a value that is retained through loss of power and can be changed via one or more of:
  - (1) A Writable Property of a standard BACnet Object

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- (2) A Property of a standard BACnet Object that is Writable when Out\_Of\_Service is TRUE and Out\_Of\_Service is Writable.
- (3) **DELETED**

c. **DELETED**

d. **DELETED**

### 3.1.3.14 **DELETED**

### 3.1.3.15 **DELETED**

## 3.1.4 Scheduling, Alarming, Trending, and Overrides

### 3.1.4.1 Scheduling

Configure schedules in BACnet Scheduling Objects to schedule systems as indicated on the Points Schedule and as specified using the indicated correspondence between value and occupancy mode. If no devices supports both the SCHED-E-B and DM-OCD-B BIBBS for Schedule Objects, provide 5 blank **DELETED** Schedule Objects in DDC Hardware BTL listed as B-BCs and supporting the SCHED-E-B BIBB for later use by the site.

Provide a separate schedule for each AHU including it's associated Terminal Units and for each stand-alone Terminal Unit (those not dependent upon AHU service) or group of stand-alone Terminal Units acting according to a common schedule as indicated.

### 3.1.4.2 Alarm Configuration

Configure alarm generation and management as indicated on the Points Schedule and as specified. Configure alarm generation in DDC Hardware **DELETED** using ASHRAE 135 Intrinsic Alarming. Configure alarm management and routing for all alarms, including those generated via intrinsic alarming in other devices **DELETED**.

Where Intrinsic Alarming is used, configure intrinsic alarming as specified in paragraph "Configuration of ASHRAE 135 Intrinsic Alarm Generation".

### 3.1.4.3 Configuration of ASHRAE 135 Intrinsic Alarm Generation

Intrinsic alarm generation must meet the following requirements:

Configure alarm generation as indicated on the Points Schedule and as specified using Intrinsic Alarming in accordance with ASHRAE 135 or Algorithmic Alarming in accordance with ASHRAE 135. Alarm generation must meet the following requirements:

- a. Send alarm events as Alarms (not Events).
- b. Use the ConfirmedNotification Service for alarm events.
- c. For alarm generation, support two priority levels for alarms: critical

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and non-critical. Configure the Priority of Notification Class Objects to use Priority 112 for critical and 224 for non-critical alarms.

d. Number of Notification Class Objects for Alarm Generation:

- (1) If the device implements non-critical alarms, or if any Object in the device supports Intrinsic Alarms, then provide a single Notification Class Object specifically for (shared by) all non-critical alarms.
- (2) If the device implements critical alarms, provide a single Notification Class Object specifically for (shared by) all critical alarms.
- (3) If the device implements both critical and non-critical alarms, provide both Notification Class Objects (one for critical, one for non-critical).
- (4) If the device controls equipment other than a single terminal unit, provide both Notification Class Objects (one for critical, one for non-critical) even if no alarm generation is required at time of installation.

e. For all intrinsic alarms configure the Limit\_Enable Property to set both HighLimitEnable and LowLimitEnable to TRUE. If the specified alarm conditions are for a single-sided alarm (only High\_Limit used or only Low\_Limit used) assign a value to the unused limit such that the unused alarm condition will not occur.

f. For all objects supporting intrinsic alarming, even if no alarm generation is required during installation, configure the following Properties as follows:

- (1) Notification\_Class to point to the non-Critical Notification Class Object in that device.
- (2) Limit\_Enable to enable both the HighLimitEnable and LowLimitEnable
- (3) Notify\_Type to Alarm

g. Use of alarm generation types:

- (1) Only use algorithmic alarm generation when intrinsic alarm generation is not supported by the device or object, or when the specific alarm conditions cannot be implemented using intrinsic alarm generation.
- (2) Only use remote alarm generation when the alarm cannot be generated using intrinsic or local algorithmic alarm generation on the device containing the referenced property. If remote alarm generation is used, use the same DDC Hardware for all remote alarm generation within a single sequence.

h. **DELETED**

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3.1.4.4 Support for Future Alarm Generation

For every piece of DDC Hardware, support future alarm generation

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capabilities by supporting either intrinsic or additional algorithmic alarming. Provide one of the following:

- a. Support intrinsic alarming for every Object used by the application in that device.
- b. Support additional Event\_Enrollment Objects. For DDC hardware controlling a single terminal unit, support at least one additional object. Otherwise, support at least 4 additional Objects. Support additional Event\_Enrollment Objects via one of the following:
  - (1) Provide unused Event\_Enrollment Objects on that device.
  - (2) Support the DM-OCD-B BIBB and the creation of sufficient Event\_Enrollment Objects on that device.
  - (3) Provide one or more devices in the IP network that support the AE-N-E-B BIBB and have unused Event\_Enrollment Objects.
  - (4) Provide one or more devices on the IP network that support the AE-N-E-B BIBB, the DM-OCD-B BIBB, and the creation of sufficient Event\_Enrollment Objects.

The total number of Event\_Enrollment Objects required by the project is the sum of the individual device requirements, and the distribution of Event\_Enrollment Objects among devices is not further restricted. (Note this allows a single device to contain many Event\_Enrollment Objects satisfying the requirements for multiple devices.)

#### 3.1.4.5 Trend Log Configuration

- a. Configure trends in Trend Log or Trend Log Multiple Objects as indicated on the Points Schedule and as specified.
- b. Configure all trend logs (including any provided to support future trends) to save data on regular intervals using the BUFFER\_FULL event to request trend upload from the front end.
- c. Configure Trend Log Objects with a minimum Buffer\_Size property value of 1,000 and Trend Log Multiple Objects with a minimum Buffer\_Size property value of 1,000 per point trended (for example, a Trend Log Multiple Object used to trend 3 points must have a Buffer\_Size Property value of at least 3,000).
- d. Configure a Notification Class Object in devices doing trending (including devices supporting future trends) to handle the BUFFER\_FULL event.
- e. When possible, trend each point using an Object in the device containing the point. When it is necessary to trend using a an Object in another device, all trends not on the same Device as the Object being trended must be on a single device (i.e. all Trend Log and Trend Log Multiple Objects used for remote trending within a sequence must be on the same device).
- f. For each trend log, including any trend logs provided to support future trending, configure the following properties as specified:
  - (1) Logging\_Type: Set to Polling

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- (2) Stop\_When\_Full: Set to Wrap Around
- (3) Buffer\_Size: Set to 400 or greater.
- (4) Notification\_Threshold: Set to 90 percent of full
- (5) Notification\_Class: Set to the Notification Class Object in that device
- (6) Event\_Enable: Set to TRUE
- (7) Log\_Interval: Set to 15 minutes.

g. Future Trending support. Provide support for future trending:

- (1) Provide one or more devices on the Building Control Network Backbone IP network which support both the T-VMT-E-B and DM-OCD-B BIBBs for Trend Log Objects. Provide sufficient devices to support the creation of at least one additional Trend Log Object for every terminal unit plus 4 additional Trend Log Objects for every non-terminal unit.
- (2) Provide one additional Trend Log Object for every terminal unit plus 4 additional Trend Log Objects for every non-terminal unit in one or more devices on the Building Control Network Backbone IP network that support the T-VMT-E-B BIBB for later use by the site.
- (3) A combination of these two methods is permitted provided the total required number of Trend Log Objects is met.

**AMENDMENT 0003**\*\*\*\*\*

3.1.4.6 **DELETED**

3.1.4.7 Overrides

Provide an override for each point shown on the Points Schedule as requiring an override. **DELETED**

Unless otherwise approved, provide Commandable Objects to support all Overrides **DELETED**. With specific approval from the Contracting Officer, Overrides for points which are not hardware outputs and which are in DDC hardware controlling a single terminal unit may support overrides via an additional Object provided for the override. No other means of implementing Overrides may be used.

\*\*\*\*\***AMENDMENT 0003**

- a. Where Commandable Objects are used, ensure that WriteProperty service requests with a Priority of 10 or less take precedence over the SEQUENCE VALUE and that WriteProperty service request with a priority of 11 or more have a lower precedence than the SEQUENCE VALUE.
- b. For devices implementing overrides via additional Objects, provide Objects which are NOT Written to as part of the normal Sequence of Operations and are Writable when Out\_Of\_Service is TRUE and Out\_Of\_Service is Writable. Use this point as an Override of the normal value when Out\_Of\_Service is TRUE and the normal value otherwise. Note these Objects may be modified as part of the sequence via local processes, but must not be modified by local processes when

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Out\_Of\_Service is TRUE.

### 3.1.5 BACnet Gateways

The requirements in this paragraph do not themselves permit the installation of hardware not meeting the other requirements of this section. Except for proprietary systems specifically indicated in Section 23 09 00, all control hardware installed under this project must meet the requirements of this specification, including the control hardware providing the network interface for a package unit or split system specified under another section. Only use gateways to connect to pre-existing control devices, and to proprietary systems specifically permitted by Section 23 09 00.

**AMENDMENT 0003**\*\*\*\*\*

#### 3.1.5.1 General Gateway Requirements

Provide BACnet Gateways to connect non-BACnet control hardware in accordance with the following:

- a. Configure gateways to map writable data points in the controlled equipment to Writable Properties of Standard Objects **DELETED** as indicated in the Points Schedule and as specified.
- b. Configure gateway to map readable data points in the controlled equipment to Readable Properties of Standard Objects **DELETED** as indicated in the Points Schedule and as specified.
- c. Configure gateway to support the DS-COV-B BIBB for all points mapped to BACnet Objects.
- d. Do not use non-BACnet control hardware for controlling built-up units or any other equipment that was not furnished with factory-installed controls. **DELETED**
- e. Do not use non-BACnet control hardware for system scheduling functions. **\*\*\*\*\*AMENDMENT 0003**
- f. Each gateway must communicate with and perform protocol translation for non-BACnet control hardware controlling one and only one package unit or a single non-BACnet system specifically permitted by Section 23 09 00.
- g. Connect one network port on the gateway to the Building Control Backbone IP Network or to a BACnet MS/TP network and the other port to the single piece of controlled equipment or the non-BACnet system specifically permitted by Section 23 09 00..
- h. For gateways to existing package units or simple split systems, non-BACnet network wiring connecting the gateway to the package unit must not exceed 10 feet in length and must connect to exactly two devices: the controlled equipment (packaged unit) or split system interface and the gateway.

-- End of Section --

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## SECTION 23 21 13.00 20

## LOW TEMPERATURE WATER (LTW) HEATING SYSTEM

**04/06, CHG 2: 11/19****Amendment 0003**

## 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 S1.4 (1983; Amendment 1985; R 2006)  
Specification for Sound Level Meters (ASA 47)

## AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.1 (2024) Unified Inch Screw Threads (UN, UNR, and UNJ Thread Form)

ASME B1.20.1 (2013; R 2018) Pipe Threads, General Purpose (Inch)

ASME B16.1 (2020) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250

ASME B16.3 (2021) Malleable Iron Threaded Fittings, Classes 150 and 300

ASME B16.5 (2020) Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard

ASME B16.9 (2024) Factory-Made Wrought Butt welding Fittings

ASME B16.11 (2021) Forged Fittings, Socket-Welding and Threaded

ASME B16.18 (2021) Cast Copper Alloy Solder Joint Pressure Fittings

ASME B16.21 (2021) Nonmetallic Flat Gaskets for Pipe Flanges

ASME B16.22 (2021) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings

ASME B16.24 (2022) Cast Copper Alloy Pipe Flanges, Flanged Fittings, and Valves Classes 150, 300, 600, 900, 1500, and 2500

ASME B16.34 (2021) Valves - Flanged, Threaded and Welding End

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|              |                                                                                                                              |
|--------------|------------------------------------------------------------------------------------------------------------------------------|
| ASME B16.36  | (2025) Orifice Flanges                                                                                                       |
| ASME B16.39  | (2025) Malleable Iron Threaded Pipe<br>Unions; Classes 150, 250, and 300                                                     |
| ASME B18.2.2 | (2022) Nuts for General Applications:<br>Machine Screw Nuts, and Hex, Square, Hex<br>Flange, and Coupling Nuts (Inch Series) |
| ASME B31.9   | (2025) Building Services Piping                                                                                              |
| ASME B40.100 | (2022) Pressure Gauges and Gauge<br>Attachments                                                                              |

#### AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

|           |                                                                                                                                            |
|-----------|--------------------------------------------------------------------------------------------------------------------------------------------|
| ASSE 1003 | (2020) Performance Requirements for Water<br>Pressure Reducing Valves for Domestic<br>Water Distribution Systems - (ANSI<br>approved 2010) |
| ASSE 1017 | (2023) Performance Requirements for<br>Temperature Actuated Mixing Valves for Hot<br>Water Distribution Systems - (ANSI<br>approved 2010)  |

#### AMERICAN WELDING SOCIETY (AWS)

|           |                                                           |
|-----------|-----------------------------------------------------------|
| AWS Z49.1 | (2021) Safety in Welding, Cutting and<br>Allied Processes |
|-----------|-----------------------------------------------------------|

#### ASTM INTERNATIONAL (ASTM)

|                 |                                                                                                                                                                 |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ASTM A53/A53M   | (2024) Standard Specification for Pipe,<br>Steel, Black and Hot-Dipped, Zinc-Coated,<br>Welded and Seamless                                                     |
| ASTM A194/A194M | (2024) Standard Specification for Carbon<br>Steel, Alloy Steel, and Stainless Steel<br>Nuts for Bolts for High-Pressure or<br>High-Temperature Service, or Both |
| ASTM A307       | (2023) Standard Specification for Carbon<br>Steel Bolts, Studs, and Threaded Rod 60<br>000 PSI Tensile Strength                                                 |
| ASTM B32        | (2020) Standard Specification for Solder<br>Metal                                                                                                               |
| ASTM B88        | (2022) Standard Specification for Seamless<br>Copper Water Tube                                                                                                 |
| ASTM D1785      | (2021) Standard Specification for<br>Poly(Vinyl Chloride) (PVC), Plastic Pipe,<br>Schedules 40, 80, and 120                                                     |
| ASTM F1007      | (2018; R 2022) Standard Specification for<br>Pipeline Expansion Joints of the Packed                                                                            |

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# Slip Type for Marine Application

ASTM F1120 (1987; R 2024) Standard Specification for  
Circular Metallic Bellows Type Expansion  
Joints for Piping Applications

## COPPER DEVELOPMENT ASSOCIATION (CDA)

CDA A4015 (2024) Copper Tube Handbook

## MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58 (2025) Pipe Hangers and Supports -  
Materials, Design and Manufacture,  
Selection, Application, and Installation

MSS SP-67 (2022) Butterfly Valves

MSS SP-70 (2011) Gray Iron Gate Valves, Flanged and  
Threaded Ends

MSS SP-72 (2010a) Ball Valves with Flanged or  
Butt-Welding Ends for General Service

MSS SP-80 (2019) Bronze Gate, Globe, Angle, and  
Check Valves

MSS SP-85 (2011) Gray Iron Globe & Angle Valves  
Flanged and Threaded Ends

MSS SP-110 (2010) Ball Valves Threaded,  
Socket-Welding, Solder Joint, Grooved and  
Flared Ends

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

SMACNA 1780 (2023) HVAC Systems - Testing, Adjusting  
and Balancing, 4th Edition

## U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-V-12003 (1980; Rev F; Am 1; CANC Notice 1) Valves,  
Plug, Cast-Iron or Steel, Manually  
Operated

## U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-1689 (Rev B) Tape, Pressure-Sensitive Adhesive,  
(Plastic Film)

CID A-A-59617 (Basic, Notice 1) Unions, Brass or Bronze,  
Threaded Pipe Connections and Solder-Joint  
Tube Connections

FS WW-S-2739 (Basic; Notice 1; Notice 2) Strainers,  
Sediment: Pipeline, Water, Air, Gas, Oil,  
or Steam

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

29 CFR 1910.144                      Safety Color Code for Marking Physical Hazards

29 CFR 1910.219                      Mechanical Power Transmission Apparatus

1.2 RELATED REQUIREMENTS

Section 23 03 00 BASIC MECHANICAL MATERIALS AND METHODS applies to this section with additions and modifications specified herein.

1.3 SYSTEM DESCRIPTION

Except as specified otherwise, equipment and piping components must be suitable for use in low temperature water heating system. Except as modified herein, the pressure temperature limitations must be as specified in the referenced standards and specifications. Pressures in this specification are pressures in pounds per square inch above atmospheric pressure, and temperatures are in degrees Fahrenheit (F).

1.3.1 Hot Water Heating System

Submit plan, elevations, dimensions, capacities, and ratings. Include the following:

a. Unit heaters

b. Valves

1.4 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Hot water heating system

SD-03 Product Data

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Convectors

Finned tube radiators

Pumps

Include pump speed and characteristic curve for performance of impeller selected for each pump. Curves must indicate capacity vs head, efficiency, and brake power for full range, from shut-off to free delivery.

Expansion tanks

Flow measuring equipment

Backflow preventers

External air separation tanks

Hot water heating pipe

#### SD-06 Test Reports

Hydrostatic test of piping system

Auxiliary equipment and accessory tests

Submit test reports in accordance with the paragraph entitled "Field Quality Control."

#### SD-07 Certificates

Backflow preventer certification

Report of prior installations

Welding procedures

Welder's qualifications

#### SD-10 Operation and Maintenance Data

Convectors, Data Package 3; G,

Finned tube radiators, Data Package 3; G,

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA. Submit a list of qualified service organizations which includes addresses and qualifications.

### 1.5 QUALITY ASSURANCE

#### 1.5.1 Standard Commercial Product for Terminal Units

Terminal units provided must comply with features called out in this specification and must be the manufacturer's standard commercial product. Additional or better features which are not prohibited by this specification but which are a part of the manufacturer's standard commercial product, must be included in the terminal units being

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furnished. A standard commercial product is a product which has been sold or is currently being offered for sale, on the commercial market through advertisements or manufacturer's catalogs, or brochures. Provide Institute of Boiler and Radiator Manufacturer (IBR) or Steel Boiler Institute (SBI) rating for required capacity.

#### 1.5.2 Welding

##### 1.5.2.1 Report of Prior Installations

Submit a Certificate of Full Approval or a current Certificate of Approval for each design, size, and make of backflow preventer being provided for the project. Certificate must be from the Foundation for Cross-Connection Control and Hydraulic Research, University of Southern California, and must attest that this design, size, and make of backflow preventer has satisfactorily passed the complete sequence of performance testing and evaluation for the respective level of approval. A Certificate of Provisional Approval is not acceptable in lieu of the above.

##### 1.5.2.2 Welding Procedures

Before performing welding, submit three copies of welding procedure specification for all metals to be used in the work, together with proof of welder's qualification as outlines in ASME B31.9.

##### 1.5.2.3 Welder's Qualifications

Before welder or operator performs welding, submit three copies of Welder's Performance Qualification Record in conformance with ASME B31.9 showing that the welder was tested under the approved procedure specification submitted by the Contractor. In addition, submit each welder's assigned number, letter, or symbol used to identify the work of the welder.

##### 1.5.2.4 Identification of Welder's Work

Ensure that each welder's assigned number, letter or symbol is affixed immediately upon completion of the weld. To welders making defective welds after passing a qualification test, give a requalification test. Upon failing to pass the test, do not permit welder to work in this contract.

##### 1.5.2.5 Previous Qualifications

Welding procedures, welders, and welding operators previously qualified by test may be accepted for this contract without requalification subject to the approval and provided that all the conditions specified in ASME B31.9 are met before a procedure can be used.

#### 1.5.3 Brazing and Soldering

##### 1.5.3.1 Brazing Procedure

ASME B31.9. Brazing procedure for joints must be as outlined in CDA A4015.

##### 1.5.3.2 Soldering, Soldering Preparation, and Procedures for Joints

ASME B31.9 and as outlined in CDA A4015.

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#### 1.5.4 Backflow Preventer Certification

Submit a Certificate of Full Approval or a current Certificate of Approval for backflow preventers.

### 1.6 SAFETY STANDARDS

#### 1.6.1 Welding

Safety in welding and cutting of pipe must conform to AWS Z49.1.

#### 1.6.2 Guards

Couplings, motor shafts, gears and other moving parts must be guarded, in accordance with OSHA 29 CFR 1910.219. Guards must be cast iron or expanded metal. Guard parts must be rigid and removable without disassembling the guarded unit.

## PART 2 PRODUCTS

### 2.1 PIPE AND FITTINGS

#### 2.1.1 Hot Water Heating Pipe (Supply and Return)

ASTM A53/A53M electric resistance welded or seamless Schedule 40 steel pipe or ASTM B88 Type L hard drawn Copper tubing.

#### 2.1.2 Fittings

Provide fittings compatible with the pipe being provided and must conform to the following requirements.

##### 2.1.2.1 Steel or Malleable Iron Pipe

Sizes 1/8 to 2 inches. ASME B16.11 steel socket welding or screwed type or ASME B16.3 for screwed type malleable iron fittings.

##### 2.1.2.2 Steel, Cast Iron, or Bronze

Sizes 2 1/2 inches and above. Steel fitting butt welding type ASME B16.9 or ASME B16.5 flanged type. Cast iron fittings flanged type ASME B16.1. Bronze fittings up to 8 inch size flanged type ASME B16.24.

##### 2.1.2.3 Fittings for Copper Tubing

ASME B16.18 cast bronze solder joint type or ASME B16.22 wrought copper solder joint type. Fittings may be flared or compression joint type.

#### 2.1.3 Unions

##### 2.1.3.1 Steel Pipe

Provide ASME B16.39, malleable iron unions, threaded connections.

##### 2.1.3.2 Copper Tubing

Provide CID A-A-59617, bronze unions, solder joint end.

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#### 2.1.3.3 Dielectric Union

Provide insulated union with galvanized steel female pipe-threaded end and a copper solder joint end conforming with ASME B16.39, Class 1, dimensional, strength and pressure requirements. Union must have a water-impervious insulation barrier capable of limiting galvanic current to one percent of the short-circuit current in a corresponding bimetallic joint. When dry, insulation barrier must be able to withstand a 600-volt breakdown test.

#### 2.1.4 Flanges

Remove raised faces when used with flanges having a flat face.

##### 2.1.4.1 Steel Flanges

ASME B16.5 forged steel, welding type.

##### 2.1.4.2 Cast Iron Screwed Flanges

ASME B16.1.

##### 2.1.4.3 Bronze Screwed Flanges

ASME B16.24.

#### 2.1.5 Drains and Overflows

##### 2.1.5.1 Steel Pipe

ASTM A53/A53M, Electric resistance welded Schedule 40, Malleable iron or forged steel fittings, screwed or welded joints.

##### 2.1.5.2 Copper Tubing

ASTM B88, Type L, hard drawn, cast brass or wrought copper fittings, Grade Sb5 solder joints.

##### 2.1.5.3 PVC Pipe

ASTM D1785, Schedule 40, solvent weld joints.

#### 2.1.6 Valves

Valves must have rising stems and must open when turned counterclockwise.

##### 2.1.6.1 Gate Valves

- a. Bronze Gate Valves: MSS SP-80, 2 inches and smaller, wedge disc, inside screw type not less than Class 150. Use solder joint ends with copper tubing.
- b. Steel Gate Valves: ASME B16.34, provide with open stem and yoke type with solid wedge or flexible wedge disc and heat and corrosion-resistant steel trim.
- c. Cast Iron Gate Valves: MSS SP-70, 2 1/2 inches and larger, open stem and yoke type with bronze trim.

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#### 2.1.6.2 Globe and Angle Valves

- a. Bronze Globe and Angle Valves: MSS SP-80, 2 inches and smaller, Class 200, except use Class 150 with solder ends for copper tubing. Valves must have renewable seat and discs except solder end valves which must have integral seats.
- b. Steel Globe and Angle Valves: ASME B16.34, provide with heat and corrosion-resistant trim.
- c. Cast Iron Globe and Angle Valves: MSS SP-85, 2 1/2 inches and larger, with bronze trim, tapped drains and brass plug.

#### 2.1.6.3 Check Valves

- a. Bronze Check Valves: MSS SP-80, 2 inches and smaller, regrinding swing check type, Class 200.
- b. Steel Swing Check Valves: ASME B16.34, regrinding swing check type, Class 200.
  - (1) Swing check valves must have bolted caps.
  - (2) Steel Lift check valves 2 inches and smaller must have bolted caps. Lift check valves 2 1/2 inches and larger must have pressure seal caps.
- c. Cast Iron Check Valves: ASME B16.34, 2 1/2 inches and larger, bronze trim, non-slam, eccentric disc type for centrifugal pump discharge service.

#### 2.1.6.4 Temperature Regulating Valves

Provide ASSE 1017 copper alloy body with adjustable range thermostat.

#### 2.1.6.5 Water Pressure-Reducing Valves

ASSE 1003.

#### 2.1.6.6 Plug Valves

MIL-V-12003, except that a replaceable valve seat will not be required. Type I - lubricated, tapered plug valves.

#### 2.1.6.7 Ball Valves

Flanged or butt-welding ends ball valve must conform to MSS SP-72, bronze. Threaded, socket-welding, solder joint, grooved and flared ends must conform to MSS SP-110.

#### 2.1.6.8 Radiator Valves

Radiator valves must be angle or straightway pattern, with packed or packless bonnet shutoff globe type, designed especially for hot water heating system. Valve must be constructed of brass or bronze or copper alloy conforming to ASTM specifications for materials with non-metallic renewable disc and plastic wheel handle for shutoff service.

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#### 2.1.6.9 Flow Control Balancing Valves

Copper alloy or cast iron body, copper alloy or stainless internal working parts, and integral pointer that indicates the degree of valve opening. Valves must be suitable for 125 psig at 190 degrees F hot water. Valve must function as a service valve when in fully closed position. Valve body must have factory-installed tapings for differential pressure meter connections for verification of pressure differential across valve orifice. Meter connections must have positive check valves or shutoff valves. Each valve must have metal tag showing the gallons per minute flow for each differential pressure reading.

#### 2.1.6.10 Butterfly Valves

Conform with MSS SP-67, Type I - Tight shut off valve, and flanged valve ends. Valve body material must be bronze and must be bubble tight for shutoff at 150 psig. Flanged and flangeless type valves must have Type 300 series corrosion resistant steel stems and corrosion resistant or bronze discs with molded elastomer disc seals. Flow conditions must be for the regulation from maximum flow to complete shutoff by way of throttling effect. Valves must be provided in closed system. Valves smaller than 8 inches must have throttling handles. Valves 8 inches and larger must have totally enclosed manual gear operators with adjustable balance return stops and indicators. Valves must have a minimum of 7 locking positions and must be suitable for water temperatures up to 200 degrees F.

#### 2.1.6.11 Butterfly Valves 2 Inches and Smaller

Valves must be one-piece and three-piece design with male or female threaded or soldered end connections and must be bubble tight for shutoff at 150 psig. Stem and disc assembly must be of 300 series corrosion resistant steel. Disc seal assembly must be of 300 series corrosion resistant steel. Disc seal must be suitable for the liquid being used in the system in which the valve is to be installed. Valves must be suitable for water temperature up to 200 degrees F and must be capable of operating at the rated pressure of 160 psig. Valves must be designed for throttling service use by valve lever and indicator adjustment.

#### 2.1.6.12 Relief Valves

Bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labelled.

#### 2.1.6.13 Valve Operating Mechanisms

Provide chainwheels where indicated and as specified.

- a. Floor Stands: Construct for bolting to the floor and include an extension stem and an operating handwheel. Design an adequately supported and guided extension stems for connection to the valve stem by a sleeve coupling or universal joint. Floor stands must be cast iron or steel. Handwheel must identify rotation direction for closing the valve and must be of such diameter as to permit operation of the valve with a force of not more than 40 pounds.
- b. Chainwheel Operator: Must be fabricated of cast iron or steel and must include a wheel, endless chain and a guide to keep the chain on the wheel. Provide galvanized steel endless chain extending to within 3 feet of the floor.

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- c. Power Operators: Must be electric . Power operated valves must open and close at rates no slower than 10 inches per minute for gate valves and 4 inches per minute for globe and angle valves. Valves must open fully or close tightly without requiring further attention when the actuating control is moved to the open or close position. A predetermined thrust exerted on the stem during operation resulting from an obstruction in the valve must cause the motor to automatically stop. Power operators must be complete with all gearing and controls necessary for the size of valve being provided. Power operators must be designed to operate on the electric power supply indicated.
- d. Extension Stem: Corrosion resisting steel designed for rising and non-rising stems. Provide in length required to connect the valve stem and the handwheel and of sufficient cross section to transfer the torque required to operate the valve.

#### 2.1.6.14 Balancing Valves

Balancing valves must be calibrated bronze body balancing valves with integral ball valve and venturi or valve orifice and valve body pressure taps for flow measurement based on differential pressure readings. Valve pressure taps and meter connections must have seals and built-in check valves with threaded connections for a portable meter. Meter must be provided by the same manufacturer and be capable of reading system pressures and must meet the requirements of the paragraph entitled "Flow Measuring Equipment." Valves must have internal seals to prevent leakage around rotating element and be suitable for full shut-off rated pressure. Valves must have an operator with integral pointer and memory stop. Balancing valves must be selected for the required flows as indicated on the plans.

#### 2.1.7 End Connections

##### 2.1.7.1 Flexible Connectors

Provide flexible pipe connectors on piping connected to equipment. Flexible section must consist of rubber, tetrafluoroethylene resin, corrosion-resistant steel, bronze, monel, or galvanized steel. Material provided and configuration must be suitable for pressure, temperature, and circulating medium. Flexible section must have welding, ends and must be suitable for service intended. Flexible section may be reinforced with metal retaining rings, with built-in braided wire reinforcement and restriction bolts or with wire braid cover suitable for service intended.

##### 2.1.7.2 Steel Piping

Screwed or socket welded for 2 inches and smaller and flanged or butt welded for 2 1/2 inches and larger.

- a. Screwed Joints With Taper Threads: ASME B1.20.1.
- b. Flanged Joints: Bolting and gaskets must be as follows:
  - (1) Bolting: Bolt and stud material ASTM A307, Grade B, and nut material ASTM A194/A194M, Grade 2. Bolt, stud, and nut dimensions ASME B18.2.2 threads ASME B1.1coarse type with Class 2A fit for bolts and studs, and Class 2B fit for nuts. Bolts or bolt studs must extend completely through the nuts and may have reduced

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shanks of a diameter not less than the diameter at root of threads. Carbon steel bolts must have American Standard regular square or heavy hexagon heads and must have American Standard heavy semifinished hexagonal nuts conforming to ASME B18.2.2.

- (2) Gaskets: ASME B16.21, Nonasbestos compressed material 1/16 inch thickness full face or self-centering flat ring type and suitable for pressure and temperature of the piping system.

c. Butt Weld Joints: ASME B31.9. Backing rings must conform to ASME B31.9. Ferrous rings must not exceed 0.05 percent sulfur; for alloy pipe, backing rings must be of material compatible with the chemical composition of the parts to be welded and preferably of the same composition. Provide continuous machined or split band backing rings.

d. Socket Weld Joints: ASME B31.9.

#### 2.1.7.3 Joints for Copper Tubing

- a. Solder conforming to ASTM B32 alloy grade Sb5 or Sn96. Solder and flux must be lead free (less than 0.2 percent of lead).
- b. Copper Tube Extracted Joint: An extracted mechanical tee joint may be made in copper tube. Make joint with an appropriate tool by drilling a pilot hole and drawing out the tube surface to form a collar having a minimum height of three times the thickness of the tube wall. To prevent the branch tube from being inserted beyond the depth of the extracted joint, provide dimpled depth stops. Notch the branch tube for proper penetration into fitting to assure a free flow joint. Braze extracted joints using a copper phosphorous classification brazing filler metal. Soldered joints must not be permitted.

#### 2.1.8 Expansion Joints

##### 2.1.8.1 Packless Type

Provide ASTM F1120, Type III with fabricated corrosion-resistant steel bellows.

##### 2.1.8.2 Guided Slip-Tube Type

Provide ASTM F1007, Type IV internally-externally guided, injected semiplastic type packing.

#### 2.1.9 Instrumentation

##### 2.1.9.1 Pressure and Vacuum Gauges

Provide ASME B40.100 with restrictor.

##### 2.1.9.2 Indicating Thermometers

Thermometers must be dial type with an adjustable angle suitable for the service. Provide thermowell sized for each thermometer in accordance with the thermowell specification. Fluid-filled thermometers (mercury is not acceptable) must have a nominal scale diameter of 5 inches. Construction must be stainless-steel case with molded glass cover, stainless-steel stem and bulb. Stem must be straight, length as required to fit well. Bimetal thermometers must have a scale diameter of 3 1/2 inches. Case must be

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hermetic. Case and stem must be constructed of stainless steel. Bimetal stem must be straight and of a length as required to fit the well.

#### 2.1.9.3 Pressure/Temperature Test Ports

Pressure/Temperature Test Ports must have brass body and EPDM and/or Neoprene valve seals. Ports must be rated for service between 35 and 275 degrees F and up to 500 psig. Ports must be provided in lengths appropriate for the insulation thickness specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS and installed to allow a minimum of 12 inches of access for probe insertion. Provide with screw-on cap attached with a strap or chain to prevent loss when removed. Ports must be 1/4 inch NPT and accept 1/8 inch diameter probes.

#### 2.1.10 Miscellaneous Pipeline Components

##### 2.1.10.1 Air Vent

Provide float type air vent in hydronic systems. Vent must be constructed of brass or semi-steel body, copper float, and stainless steel valve and valve seat. Design air vent to suit system operating temperature and pressure. Provide isolating valve to permit service without draining the system. Pipe discharge of vent to a drain.

##### 2.1.10.2 Strainers

Strainers for classes 125 and 250 piping in IPS 1/2 to 8 inches, inclusive, FS WW-S-2739 and locate as indicated.

##### 2.1.10.3 Hangers and Supports

Design and fabrication of pipe hangers, supports, and welding attachments must conform to MSS SP-58 and ASME B31.9. Hanger types and supports for bare and covered pipe must conform to MSS SP-58 for the temperature range.

##### 2.1.10.4 Pipe Sleeves

Sleeves in masonry and concrete walls, floors, and roof slabs must be ASTM A53/A53M, Schedule 40 or Standard Weight, hot-dip galvanized steel pipe. Sleeves in partitions must be zinc-coated sheet steel having a nominal weight of not less than 0.906 pound per square foot.

##### 2.1.10.5 Escutcheon Plates

Provide one piece or split hinge metal plates for piping passing through floors, walls, and ceilings in exposed spaces. Provide polished stainless steel plates or chromium-plated finish on copper alloy plates in finished spaces and paint finish on metal plates in unfinished spaces.

#### 2.2 PIPING SYSTEM EQUIPMENT

##### 2.2.1 Flow Measuring Equipment

Orifice or venturi type. Flow metering equipment including pitot tubes, venturis, orifice plates, flanges, and indicating meters must be the product of one and the same manufacturer. Provide flowmeters of permanent type. Flowmeters must be suitable for service in which they are to be installed. Primary elements of flowmeters must conform to ASME recommendations for flowmeters. Provide bronze, monel, or stainless steel

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materials for wetted parts of flow meters.

- a. Orifices: Square-edge type, made of corrosion and erosion resistant metal and mounted between pipe flanges having factory-made pressure taps provided with shutoff valves. Orifice flanges must conform to ASME B16.36.
- b. Tubular Flowmeters: Flow measuring elements consisting of venturi tubes or pitot tubes where indicated. Locations and arrangement of piping, both upstream and downstream of flow measuring elements must conform to the manufacturer's published literature. Provide each flow measuring element with an integral tab, or a metal tag on a corrosion-resistant steel wire, extending outside pipe covering, and stamped or printed in a visible position with manufacturer's name and address; serial number of meter to which it is to be connected; name, number, or location of equipment served; specified rate of flow; and multiplier to be applied to meter reading. Provide taps with shutoff valves and quick connecting hose fittings for portable meters or double ferrule compression fittings for connection to tubing for permanently located meters or recorders. Tubes must be calibrated in accordance with ASME recommendations.
  - (1) Venturi Tubes: Certified by the manufacturer for the actual piping configuration and any necessary piping changes required for certification without additional cost to the Government. Throat diameter for each venturi tube must be designed so that at specified rate of flow the scale reading will fall between 50 percent and 80 percent of full scale value. Select venturi tube sizes from the manufacturer's latest published tables of flow versus differential pressure. Unrecovered head loss at maximum flow must not exceed 10 percent. Provide bronze or cast iron tubes with bronze-lined throats, with flanged, threaded, or welded ends to suit piping system. Provide bodies of fabricated steel and fittings of the same class as piping in which installed. Two integral meter taps must be provided in each venturi tube. Connections for attachment to portable flow meter hoses must be readily accessible and not over 6 feet above a floor or permanent platform.
  - (2) Pitot Tube Assemblies: Provide corrosion-resistant materials. Tubes must be capable of measuring liquid flow through tube elements providing an averaged, interpolated flow measurement from a single, fixed position. Provide self cleaning elements and impact tube designed to rotate when turned by the operator to protect pressure-sensing elements of tube when not in use. Location and total amount of pitot tubes required for system flow measurement must be as recommended by the manufacturer and as indicated.
- c. Meters: Designed for a full scale pressure differential of 50 inches water gage for tubular type or 100 inches water gage for orifice type. Dials must have square root or linear scales with developed length of not less than 12 inches. Provide flush mounted panel meters that read directly in gallons per minute. Dials of portable meters must have square root scales reading from 0 to 100 gpm for use with multiplier stamped on orifice or tubular type. Provide meters designed for not less than 200 psi and protected against pressure surges. Meter bodies must have taps for venting and draining.

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- (1) Permanently Mounted Meters: Each meter must be connected completely as specified and provided with the following: three valve manifold equalizer lines, two block valves, two vent and drain valves, and an integral pulsation damper. Overall accuracy of meters must be plus or minus 2 percent of full scale flow over a range from 20 to 100 percent of full scale flow.
- (2) Portable Meters: Provide meter with a factory-fabricated carrying case with carrying handle. Provide case fitted to hold meter securely and to accommodate the following accessories:
  - (a) Two 15 foot lengths of connecting hose with suitable female connectors for connecting from meter to venturi tube pressure-tap nipples. Provide hose designed for a minimum service pressure of 125 psi or 150 percent of maximum system service pressure, whichever is greater.
  - (b) A completely assembled three-valve manifold with two block valves and vent and drain valves, piped and mounted on a base designed for use laying flat on a stationary surface.
  - (c) A bound set of descriptive bulletins, installation and operating instructions, parts list, and a set of curves showing flow versus pressure differential for each orifice, venturi tube, or pitot tube with which meter is to be used.
  - (d) A metal instruction plate, secured inside cover, illustrating use of meter.
  - (e) Provide meters with overall accuracy of plus or minus 5 percent of full scale flow over a range from 20 to 100 percent of full scale flow.

## 2.3 TERMINAL UNITS

### 2.3.1 Heating and Ventilating Units

Provide fan-coil units, induction units, unit ventilators, and gravity ventilators as specified in Section 23 30 00 HVAC AIR DISTRIBUTION.

## 2.4 ELECTRICAL EQUIPMENT

Provide complete with motors, motor starters, thermal overload protection, and controls. Equipment and wiring must be in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

## 2.5 CONTROLS

Provide controls as specified in Section 23 09 53.00 20 SPACE TEMPERATURE CONTROL SYSTEMS.

## 2.6 INSULATION

Provide shop and field applied insulation as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

## 2.7 ASBESTOS PROHIBITION

Asbestos and asbestos containing products are prohibited.

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## PART 3 EXECUTION

### 3.1 PREPARATION

Provide storage for equipment and material at the project site. All parts must be readily accessible for inspection, repair, and renewal. Protect material and equipment from the weather.

### 3.2 INSTALLATION

Piping fabrication, assembly, welding, soldering, and brazing must conform to ASME B31.9. Piping must follow the general arrangement shown. Route piping and equipment within buildings out of the way of lighting fixtures and doors, windows, and other openings. Run overhead piping in buildings in inconspicuous positions. Provide adequate clearances from walls, ceilings, and floors to permit welding of joints and application of insulation. Make provision for expansion and contraction of pipe lines. Make changes in size of water lines with reducing fittings. Do not bury, conceal, or insulate until piping has been inspected, tested, and approved. Do not run piping concealed in walls, partitions, underground, or under the floor except as otherwise indicated. Where pipe passes through building structure, locate pipe joints and expansion joints where they may be inspected. Provide flanged joints where necessary for normal maintenance and where required to match valves and equipment. Furnish gaskets, packing, and thread compounds suitable for the service. Provide long radius ells where possible to reduce pressure drops. Pipe bends in lieu of welding fittings may be used where space permits. Pipe bends must have a uniform radius of at least five times the pipe diameter and must be free from appreciable flattening, wrinkling, or thinning of the pipe. Do not use mitering of pipe to form elbows, notching straight runs to form full sized tees, or any similar construction. Make branch connections over 2 inches with welding tees except factory made forged welding branch outlets or nozzles having integral reinforcements conforming to ASME B31.9 may be used, provided the nominal diameter of the branch is at least one pipe size less than the nominal diameter of the run. Branch connections 2 inches and under can be threaded or welded. Run vertical piping plumb and straight and parallel to walls. Provide sleeves for lines passing through building structure. Provide a fire seal where pipes pass through fire wall, fire partitions, fire rated pipe chase walls, or floors above grade. Install piping connected to equipment with flexibility for thermal stresses and for vibration, and support and anchor so that strain from weight and thermal movement of piping is not imposed on the equipment.

#### 3.2.1 Hangers and Supports

Unless otherwise indicated, horizontal and vertical piping attachments must conform to MSS SP-58. Band and secure insulation protection shields without damaging pipe insulation. Continuous inserts and expansion bolts may be used.

#### 3.2.2 Grading of Pipe Lines

Unless otherwise indicated, install horizontal lines of hot water piping to grade down in the direction of flow with a pitch of not less than one inch in 30 feet, except in loop mains and main headers where the flow may be in either direction.

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### 3.2.3 Pipe Sleeves

Provide sleeves where pipes and tubing pass through masonry or concrete walls, floors, roof, and partitions. Annular space between pipe, tubing, or insulation and the sleeve must not be less than 1/4 inch. Hold sleeves securely in proper position and location before and during construction. Sleeves must be of sufficient length to pass through entire thickness of walls, partitions, or slabs. Sleeves in floor slabs must extend 2 inches above finished floor. Firmly pack space between pipe or tubing and sleeve with oakum and caulk on both ends of the sleeve with plastic waterproof cement which will dry to a firm but pliable mass, or provide a segmented elastomeric seal. Seal both ends of penetrations through fire walls and fire floors to maintain fire resistive integrity with UL listed fill, void, or cavity material.

### 3.2.4 Flashing for Buildings

Provide flashing where pipes pass through building roofs, and make outside walls tight and waterproof.

### 3.2.5 Unions and Flanges

Provide unions and flanges to permit easy disconnection of piping and apparatus. Each connection having a screwed-end valve must have a union. Place unions and flanges no farther apart than 100 feet. Install unions downstream of valves and at equipment or apparatus connections. Provide unions on piping under 2 inches in diameter, and provide flanges on piping 2 inches and over in diameter. Provide dielectric unions or flanges between ferrous and non-ferrous piping, equipment, and fittings; except that bronze valves and fittings may be used without dielectric couplings for ferrous-to-ferrous or non-ferrous-to-non-ferrous connections.

### 3.2.6 Connections for Future Equipment

Locate capped or plugged outlets for connections to future equipment as indicated.

### 3.2.7 Changes in Pipe Size

Provide reducing fittings for changes in pipe size; reducing bushings are not permitted. In horizontal lines, provide eccentric reducing fittings to maintain the top of the lines in the same plane.

### 3.2.8 Cleaning of Pipe

Thoroughly clean each section of pipe, fittings, and valves free of foreign matter before erection. Prior to erection, hold each piece of pipe in an inclined position and tap along its full length to loosen sand, mill scale and other foreign matter. For pipe 2 inches and larger, draw wire brush, of a diameter larger than that of the inside of the pipe, several times through the entire length of pipe. Before making final connections to apparatus, wash out interior of piping thoroughly with water. Plug or cap open ends of mains during shutdown periods. Do not leave lines open where foreign matter might enter the pipe.

### 3.2.9 Valves

Install valves in conformance with ASME B31.9. Provide gate valves unless otherwise directed. Install valves with stems horizontal or above. Locate

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or equip stop valves to permit operation from floor level, or provide with safe access in the form of walkways or ladders. Install valves in positions accessible for operation and repair.

#### 3.2.9.1 Globe Valves

Install globe valves so that the pressure is below the disk and the stem horizontal.

#### 3.2.9.2 Radiators Valves

Provide radiator valves on water inlet and balancing valves on water outlet of terminal heating units such as radiation, unit heaters, and fan coil unit.

#### 3.2.9.3 Relief Valves

Provide valves on pressure tanks, low pressure side of reducing valves, heat exchangers, and expansion tanks. Select system relief valve so that capacity is greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment. Pipe relief valve outlet to the nearest floor drain.

#### 3.2.10 Pressure Gage

Provide a shut-off valve or pet cock between pressure gages and the line.

#### 3.2.11 Thermometers

Provide thermometers and thermal sensing elements of control valves with a separable socket. Install separable sockets in pipe lines in such a manner to sense the temperature of flowing the fluid and minimize obstruction to flow.

#### 3.2.12 Strainers

Provide strainers, with meshes suitable for the services, where indicated, or where dirt might interfere with the proper operation of valve parts, orifices, or moving parts of equipment.

#### 3.2.13 Equipment Installation

Install equipment in accordance with installation instructions of the manufacturers. Grout equipment mounted on concrete foundations before installing piping. Install piping in such a manner as not to place a strain on the equipment. Do not bolt flanged joints tight unless they match. Grade, anchor, guide, and support piping without low pockets.

#### 3.2.14 Cleaning of Systems

As installation of the various system components is completed, fill, start, and vent prior to cleaning. Place terminal control valves in open position. Add cleaner to closed system at concentration as recommended by manufacturer. Apply heat while circulating, slowly raising temperature to 160 degrees F and maintain for 12 hours minimum. Remove heat and circulate to 100 degrees F or less; drain systems as quickly as possible and refill with clean water. Circulate for 6 hours at design temperatures, then drain. Refill with clean water and repeat until system cleaner is removed. Use neutralizer agents on recommendation of system cleaner

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supplier and approval of Contracting Officer. Remove, clean, and replace strainer screens. Inspect, remove sludge, and flush low points with clean water after cleaning process is completed. Include disassembly of components as required. Preliminary or final tests are not permitted until cleaning is approved.

### 3.2.15 Painting of Piping and Equipment

Provide in accordance with Section 09 90 00 PAINTS AND COATINGS.

### 3.2.16 Identification of Piping

Identify piping in accordance with OSHA 29 CFR 1910.144, except that labels or tapes may be used in lieu of painting or stenciling. Spacing of identification marking on runs must not exceed 50 feet. Materials for labels and tapes must conform to CID A-A-1689, and must be general purpose type and color class. Painting and stenciling must conform to Section 09 90 00 PAINTS AND COATINGS.

## 3.3 FIELD QUALITY CONTROL

Perform inspections and tests as specified herein to demonstrate that piping and equipment, as installed, is in compliance with contract requirements. Start up and operate the system. During this time, periodically clean the various strainers until no further accumulation of foreign material occurs. Exercise care so that minimum loss of water occurs when strainers are cleaned. Adjust safety and automatic control instruments to place them in proper operation and sequence.

### 3.3.1 Hydrostatic Test of Piping System

Test piping system hydrostatically using water not exceeding 100 degrees F. Conduct tests in accordance with the requirements of ASME B31.9 and as follows. Test piping system after all lines have been cleaned and before applying insulation covering. Remove or valve off from the system, gages, and other apparatus which may be damaged by the test before the tests are made. Install calibrated test pressure gage in the system to observe any loss in pressure. Maintain test pressure for a sufficient length of time to enable an inspection of each joint and connection. Perform tests after installation and prior to acceptance. Notify the Contracting Officer in writing 10 days prior to the time scheduled for the tests.

### 3.3.2 Auxiliary Equipment and Accessory Tests

Observe and check pumps, accessories, and equipment during operational and capacity tests for leakage, malfunctions, defects, noncompliance with referenced standards, or overloading.

#### 3.3.2.1 Backflow Preventers

Backflow preventers must be tested by locally approved and certified backflow assembly testers. A copy of the test report must be provided to the Contracting Officer prior to placing the domestic water system into operation, or no later than 5 days after the test.

## 3.4 TESTING, ADJUSTING, AND BALANCING

Except as specified herein, perform in accordance with SMACNA 1780, Chapter VIII "Hydronic System TAB Procedures," drawings and specifications; prepare

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complete report of final test results.

#### 3.4.1 Markings of Settings

Following final acceptance of the balancing report, the settings of all valves, splitters, dampers, and other adjustment devices must be permanently marked so that adjustment can be restored if disturbed at anytime.

#### 3.4.2 Sound Level Tests

Upon completion of testing and balancing of hydronic systems, conduct sound level tests of conditioned spaces. Use sound level meter required by ASA S1.4, Type 2, calibrated in accordance with NBS standards and guidelines, and accompanied by a certificate of calibration. Record sound levels in dBA with heating systems off and with heating systems operating. Record the following data for each room and system:

- a. Background sound level (systems off);
- b. Total sound level corrected for background; and
- c. Sound power rating by manufacturer of the respective outlet.

Test Locations: Take sound level reading at location 6 feet from face of each outlet on a line at 45 degrees with face of outlet. Remedial Action: If sound level at any observation point exceeds 20 dBA, take remedial action as directed.

-- End of Section --

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SECTION 26 05 73

POWER SYSTEM STUDIES

08/23

Amendment 0003

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 1584   | (2018; E 2019) Guide for Performing Arc-Flash Hazard Calculations                                                        |
| IEEE 1584.1 | (2022) Guide for the Specification of Scope and Deliverable Requirements for an Arc-Flash Hazard Calculation Study       |
| IEEE 3002.2 | (2018) Recommended Practice for Conducting Load-Flow Studies and Analysis of Industrial and Commercial Power Systems     |
| IEEE 3002.3 | (2018) Recommended Practice for Conducting Short-Circuit Studies and Analysis of Industrial and Commercial Power Systems |
| IEEE C2     | (2023) National Electrical Safety Code                                                                                   |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

|          |                                                        |
|----------|--------------------------------------------------------|
| NFPA 70E | (2024) Standard for Electrical Safety in the Workplace |
|----------|--------------------------------------------------------|

U.S. DEPARTMENT OF DEFENSE (DOD)

|              |                                                                          |
|--------------|--------------------------------------------------------------------------|
| UFC 3-560-01 | (2017; with Change 3, 2023) Operation and Maintenance: Electrical Safety |
|--------------|--------------------------------------------------------------------------|

Amendment 0003\*\*\*\*\*

1.2 SYSTEM DESCRIPTION

The power system covered by this specification consists of:  
**All new and existing equipment starting at utility service entrance.**

\*\*\*\*\*Amendment 0003

1.3 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

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SD-01 Preconstruction Submittals

Field Examination Plan;

Arc Flash Label Formats;

SD-06 Test Reports

Field Examination

SD-07 Certificates

System Analyzer;

SD-11 Closeout Submittals

Model Files;

Load Flow Study;

Fault Current Study;

System Coordination Study;

Arc Flash Hazard Study;

1.4 QUALITY ASSURANCE

1.4.1 System Analyzer

The System Analyzer must perform the power system studies. The System Analyzer must be a registered professional electrical engineer with a minimum of 3 years of experience with power system studies. Include a list of three comparable jobs performed by the System Analyzer with specific names and telephone numbers for reference. Include the license number and state of the registered Professional Engineer.

1.4.2 System Verifier

The System Verifier may inspect and record settings, markings, and otherwise document the existing equipment. The System Verifier may also place appropriate hazard labels on equipment. The System Verifier must not make any calibrations or adjustments or place equipment into service. When working with energized equipment, the system verifier must be a Qualified Person per NFPA 70E or working under the direct supervision of a Qualified Person. The System Verifier may communicate with the system owner to determine if the equipment within the studied system has received maintenance and testing in accordance with NETA MTS or NFPA 70B.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.1 FIELD EXAMINATION

For each pre- and post-study inspection, submit a field examination plan identifying which facilities must be examined to complete the required

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work. Include a complete information verification procedure, where Qualified Personnel will be required, PPE requirements for "live" equipment examinations, and equipment to be used within the limited approach boundary of the equipment.

#### 3.1.1.1 General

Perform field inspections of the site and equipment before the first study and after the last study to determine the state and settings of the equipment and to verify the final settings agree with the studies. Perform the post-study inspection(s) after changing settings, after performing acceptance tests, and before placing equipment in service.

Schedule the field examination by the System Verifier with the Contracting Officer at least 10 business days before conducting examination. Furnish all materials, labor, and equipment necessary to conduct the examination. Maintain a written record of the all equipment examined, equipment location, equipment ratings, settings, personnel involved, and the date the examination was performed. Submit the written record of each field examination.

#### 3.1.1.2 Safety

Where examination of the equipment requires energized equipment to be opened, provide a Qualified Person to directly supervising any non-Qualified Person within the hazard area. Use PPE, protective barriers, danger signs and other safety devices to protect and warn personnel in the vicinity of "live" equipment being examined.

#### 3.1.1.3 Application of Arc Flash Labels

Install arc flash warning labels using Qualified Personnel as necessary after the setting and inspection is complete. For new or modified equipment, install labels before the equipment is energized for the first time after installation/modification or setting changes. Schedule the label placement with the Contracting Officer at least 5 business days before label placement. Furnish all materials, labor, and equipment necessary to place the labels. Maintain a written record of the all equipment that received labels, personnel involved, and the date labels were placed.

### 3.2 POWER SYSTEM STUDIES

Perform power system studies to demonstrate that the equipment selected and system constructed meet the contract requirements for fault current and interrupt ratings, coordination, protection, and Arc Flash Hazard. Submit reports of the studies along with protective device equipment submittals. Apply Arc Flash Hazard labels to equipment after the studies are approved. Update and resubmit the studies after any changes to the equipment or systems which may affect the study results, and re-apply Arc Flash Hazard labels to equipment after the resubmitted studies are approved. The Government is not responsible for any changes to equipment, device ratings, settings, or additional labor for installation of equipment or devices or labels ordered and/or procured before approval of the study.

Perform power system studies to demonstrate the system operation with regard to ratings, coordination, protection, and Arc Flash Hazard.

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### 3.2.1 Scope of Studies

The scope of the studies must begin at the utility service entrance of a building and extend down to load buses/panels where the fault current is 2,000 amperes or less (symmetrical) for distribution buses nominally operating at 208 volt AC and above.

The "source bus" is the source of energy for system being analyzed. This may be the energy feed from a utility, the first bus upstream of the work, generators within the work or upstream of the work, or any other source capable of contributing significant energy into the system being analyzed.

In the systems model for the studies, incorporate all existing and new equipment within the scope of the studies. Incorporate any additional sources or load equipment necessary to accurately model the system's performance.

### 3.2.2 Determination of Facts

Determine and document the time-current characteristics, features, ratings, ampacities, and nameplate data for each existing protective device, electrical equipment, and feeder cables. Obtain the available fault current from the owner of the source bus.

Utilize field-verified data in the power system studies. Document the field-verified data in the report.

### 3.2.3 Single Line Diagram

Provide a single line diagram showing the electrical system buses, devices, transformation points, and all sources of load current and fault current, including generator and motor contributions. Provide a diagram from the system model. Each bus, device or transformation point must have a unique identifier. Show the location of switches, breakers, and circuit interrupting devices on the diagram together with available fault data, and the device interrupting rating.

The naming of existing components within the system model and single line diagram must match existing installed equipment names. The naming of new components within the system model and single line diagram must use unique identifiers and be coordinated with the Government.

### 3.2.4 Load Flow Study

Perform the load flow study in accordance with IEEE 3002.2 to identify initial steady-state conditions for the fault current study. For each operating scenario, provide load flow results on the diagram or in the report. Show or describe the loading factors and assumptions used in each operating mode.

### 3.2.5 Fault Current Study

Use the results of the load flow study to perform the fault current study in accordance with IEEE 3002.3. Provide balanced three-phase fault, bolted

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line-to-line fault, and single line-to-ground fault current values at each voltage transformation point and at each power distribution bus. For each location, show in tabular form on the diagram or in the report the maximum and minimum available fault currents of all modes of operation for that location.

Where the available fault current at the source bus is not available, describe how the fault contribution from the source bus was determined and why this method is reasonable for the study.

### 3.2.6 System Coordination Study

Use the results of the load flow study and fault current study. For normal modes of operation, demonstrate that selectivity has been obtained between the devices within the scope of the project. Demonstrate the equipment, machines, and conductors are protected from damage from overloads and fault conditions. Include a description of the coordination of the protective devices in this project. Provide a written narrative 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; coordination between upstream and downstream devices; and relay settings. Provide 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). Provide composite coordination plots on a log-log scale. Where recommendations are provided to improve or enhance system reliability, provide separate coordination plots on log-log scale showing the system coordination before and after the implementation of the recommendations. Where coordination has been adjusted to lower arc flash values, include a discussion of the change and the impact on the system within the report.

### 3.2.7 Arc Flash Hazard Study

Perform the arc flash hazard study in accordance with IEEE 1584.1. Utilize the data from the fault current study to determine the worst case incident energy per IEEE 1584, IEEE C2, and OSHA 29 CFR 1910.269 Appendix E. Use identified modes of operation to determine the worst case arc flash energy. If not included in another study, include a description of the devices and device settings for the operating modes that provided the highest arc flash energy. The use of a "maintenance switch" to temporarily reduce the Arc Flash incident energy for maintenance work is acceptable. Where the adjusting the coordination of devices to obtain lower arc flash values, include a discussion of the change and the impact on the system within the report. Where the arc flash energies exceed  $1.2 \text{ cal/cm}^2$  provide recommendations to reduce the arc flash energy to  $1.2 \text{ cal/cm}^2$ .

### 3.2.8 Study report(s)

- a. Include a narrative describing the studies performed; the bases and methods used; and the desired method of coordinated protection of the power system.
- b. Include descriptive and technical data for existing devices and new protective devices proposed. Include manufacturers published data, nameplate data, and definition of the fixed or adjustable features of the existing or new protective devices. For existing devices, included statements on the condition of the equipment based upon field

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inspections and owner's statements and reports.

- c. 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; and existing power system data including time-current characteristic curves and protective device ratings and settings. Identify all assumptions about the protection devices, equipment, and system where data was not available.
- d. For each bus in the system, provide fully coordinated composite time-current characteristics (TCC) curves as required to ensure coordinated power system protection between protective devices and equipment. In a tabular format, provide existing and recommended ratings and settings of all protective devices.
- e. Provide an arc flash study report in accordance with IEEE 1584.1.
- f. Provide the calculations performed for the studies, including computer programs utilized. Provide the name of the software package, developer, and version number.

### 3.2.9 Arc Flash Labels

Provide arc flash warning labels on electrical equipment likely to require examination, servicing, or maintenance while energized. Typical types of equipment include pad-mounted transformers, switchgear, switchboards, panelboards, disconnect switches, industrial control panels, meter socket enclosures, and motor control centers that are in other than dwelling occupancies. The arc flash label naming must match the naming used in the system modeling and the single line diagram.

Comply with the label requirements specified in UFC 3-560-01. Obtain approval of arc flash label formats before printing.

- a. Provide a 3.5 inch x 5 inch to 4 inch x 6 inch thermal transfer type label of high adhesion polyester for each location device analyzed. The label must remain in place and be legible for at least 5 years in the installed environment.
- b. Labels must be machine printed with no field markings. Provide arc flash labels in the following manner. All labels must be based on implemented overcurrent devices and settings.
  - 1. Provide at least one arc flash label for each 480 volt and 208 volt panelboards.
  - 2. Provide at least one arc flash label for each low voltage (less than 1000 V) switchboard.
  - 3. Where the equipment construction has different hazards levels in different areas, provide a label for each compartment, cubicle, or section separated by barriers.
- c. Use the worst case hazard of all operating scenarios unless mitigation procedures are used. If mitigation procedures are used, explain the procedures on the label.

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### 3.3 MODELING

Develop a software model of the electrical system identified in the scope of the studies. Use the latest version of SKM PowerTools(TM) or EasyPower(TM). Develop the model with accurate, verified information. Model existing electrical equipment, machines, devices, and conductors directly connected to, altered by, or otherwise affected by the work. This includes, but is not limited to generators, transformers, switchgear, switchboards, panelboards, motor control centers, motors, voltage regulators, tap changers, protective relays, circuit breakers, switches, fuses, conductors, capacitors, reactors, grounding system, and control equipment.

Provide the final model files in their native editable formats for future use by the Government. Include device information for devices not in the software vendor's standard distribution.

-- End of Section --

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## SECTION 26 12 19

## PAD-MOUNTED, LIQUID-FILLED, MEDIUM-VOLTAGE TRANSFORMERS

**05/24****Amendment 0003**

## 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 (ACI)

ACI 318 (2019; R 2022) Building Code Requirements  
for Structural Concrete (ACI 318-19) and  
Commentary (ACI 318R-19)

## AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C12.1 (2014; Errata 2016) Electric Meters - Code  
for Electricity Metering

## ASTM INTERNATIONAL (ASTM)

ASTM A240/A240M (2025a) Standard Specification for  
Chromium and Chromium-Nickel Stainless  
Steel Plate, Sheet, and Strip for Pressure  
Vessels and for General Applications

ASTM D92 (2012a) Standard Test Method for Flash and  
Fire Points by Cleveland Open Cup Tester

ASTM D97 (2017b) Standard Test Method for Pour  
Point of Petroleum Products

ASTM D877/D877M (2019) Standard Test Method for Dielectric  
Breakdown Voltage of Insulating Liquids  
Using Disk Electrodes

ASTM D1535 (2014; R 2018) Standard Practice for  
Specifying Color by the Munsell System

## FM GLOBAL (FM)

FM APP GUIDE (updated on-line) Approval Guide  
<https://www.approvalguide.com/>

## INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 386 (2016) Separable Insulated Connector  
Systems for Power Distribution Systems  
Rated 2.5 kV through 35 kV

IEEE C2 (2023) National Electrical Safety Code

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|                      |                                                                                                                                                                                                                                                       |
|----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| IEEE C37.47          | (2011) Standard for High Voltage Distribution Class Current-Limiting Type Fuses and Fuse Disconnecting Switches                                                                                                                                       |
| IEEE C57.12.00       | (2021) General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers                                                                                                                                                      |
| IEEE C57.12.28       | (2023) Standard for Pad-Mounted Equipment - Enclosure Integrity                                                                                                                                                                                       |
| IEEE C57.12.34       | (2022) Standard Requirements for Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers, 10 MVA and Smaller; High Voltage, 34.5 kV Nominal System Voltage and Below; Low Voltage, 15 kV Nominal System Voltage and Below |
| IEEE C57.12.80       | (2010) Standard Terminology for Power and Distribution Transformers                                                                                                                                                                                   |
| IEEE C57.12.90       | (2021) Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers                                                                                                                                                                 |
| IEEE C57.98          | (2011) Guide for Transformer Impulse Tests                                                                                                                                                                                                            |
| IEEE C62.11          | (2020) Standard for Metal-Oxide Surge Arresters for Alternating Current Power Circuits (>1kV)                                                                                                                                                         |
| IEEE Stds Dictionary | (2009) IEEE Standards Dictionary: Glossary of Terms & Definitions                                                                                                                                                                                     |

#### INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

|          |                                                                                                  |
|----------|--------------------------------------------------------------------------------------------------|
| NETA ATS | (2025) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems |
|----------|--------------------------------------------------------------------------------------------------|

#### NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

|             |                                                                                                |
|-------------|------------------------------------------------------------------------------------------------|
| NEMA 260    | (1996; R 2004) Safety Labels for Pad-Mounted Switchgear and Transformers Sited in Public Areas |
| NEMA Z535.4 | (2023) Product Safety Signs and Labels                                                         |

#### NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

|         |                                                                  |
|---------|------------------------------------------------------------------|
| NFPA 70 | (2023; ERTA 1 2024; TIA 24-1; TIA 25-2) National Electrical Code |
|---------|------------------------------------------------------------------|

#### ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT (OECD)

|               |                                 |
|---------------|---------------------------------|
| OECD Test 203 | (1992) Fish Acute Toxicity Test |
|---------------|---------------------------------|

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U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

|                  |                                                                                                                            |
|------------------|----------------------------------------------------------------------------------------------------------------------------|
| EPA 712-C-98-075 | (1998) Fate, Transport and Transformation<br>Test Guidelines - OPPTS 835.3100- "Aerobic<br>Aquatic Biodegradation"         |
| EPA 821-R-02-012 | (2002) Methods for Measuring the Acute<br>Toxicity of Effluents and Receiving Waters<br>to Freshwater and Marine Organisms |

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

|            |                                                                              |
|------------|------------------------------------------------------------------------------|
| 10 CFR 431 | Energy Efficiency Program for Certain<br>Commercial and Industrial Equipment |
|------------|------------------------------------------------------------------------------|

UL SOLUTIONS (UL)

|        |                                                                  |
|--------|------------------------------------------------------------------|
| UL 467 | (2022) UL Standard for Safety Grounding<br>and Bonding Equipment |
|--------|------------------------------------------------------------------|

1.2 RELATED REQUIREMENTS

Section 26 08 00 APPARATUS INSPECTION AND TESTING applies to this section, with the additions and modifications specified herein.

1.3 DEFINITIONS

Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, are as defined in IEEE Stds Dictionary.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Pad-mounted Transformer Drawings;

SD-03 Product Data

Pad-mounted Transformers;

SD-06 Test Reports

Acceptance Checks and Tests;

SD-07 Certificates

Transformer Efficiencies;

SD-09 Manufacturer's Field Reports

Transformer Test Schedule;

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Pad-mounted Transformer Design Tests;

Pad-mounted Transformer Routine and Other Tests;

SD-10 Operation and Maintenance Data

Transformer(s), Data Package 5;

#### 1.4.1 Reduced Submittal Requirements

Transformers designed and manufactured by ABB/Hitachi Energy in Jefferson City, MO; by Eaton's Cooper Power Series Transformers in Waukesha, WI; by ERMCO in Dyersburg, TN; or by Howard Industries in Laurel, MS need not submit the entire submittal package requirements of this contract. Instead, submit the following items:

- a. A certification, signed by the manufacturer, stating that the manufacturer will meet the technical requirements of this specification.
- b. An outline drawing of the transformer with devices identified (paragraph PAD-MOUNTED TRANSFORMER DRAWINGS, item a).
- c. ANSI nameplate data of the transformer (paragraph PAD-MOUNTED TRANSFORMER DRAWINGS, item b).
- d. Provide transformer test schedule and routine and other tests required by submittal item "SD-09 Manufacturer's Field Reports".
- e. Provide acceptance test reports required by submittal item "SD-06 Test Reports".
- f. Provide operation and maintenance manuals required by submittal item "SD-10 Operation and Maintenance Data".

#### 1.5 QUALITY ASSURANCE

##### 1.5.1 Pad-Mounted Transformer Drawings

Include the following as a minimum:

- a. An outline drawing, including front, top, and side views.
- b. IEEE nameplate data.
- c. Elementary diagrams and wiring diagrams with terminals identified of watt-hour meter and current transformers.
- d. One-line diagram, including switch(es), current transformers, meters, and fuses.

##### 1.5.2 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, except of NFPA 70 when more stringent requirements are specified or indicated, as though the word "must" 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. Provide equipment, materials, installation, and workmanship in accordance with NFPA 70 unless

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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, and:

- a. Have been in satisfactory commercial or industrial use for 2 years prior to bid opening including applications of equipment and materials under similar circumstances and of similar size.
- b. Have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period.
- c. 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 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.

##### 1.5.3.2 Material and Equipment Manufacturing Date

Products manufactured more than 3 years prior to date of delivery to site are not acceptable.

#### 1.6 MAINTENANCE

##### 1.6.1 Additions to Operation and Maintenance Data

Submit operation and maintenance data in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA and as specified herein. In addition to requirements of Data Package 5, include the following on the actual transformer(s) provided:

- a. An instruction manual with pertinent items and information highlighted
- b. An outline drawing, front, top, and side views
- c. Prices for spare parts and supply list
- d. Routine and field acceptance test reports
- e. Fuse curves for primary fuses
- f. Information on watthour demand meter, CT's, and fuse block
- g. Actual nameplate diagram
- h. Date of purchase

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## PART 2 PRODUCTS

### 2.1 PRODUCT COORDINATION

Products and materials not considered to be pad-mounted transformers and related accessories are specified in Section 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION, Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM, .

### 2.2 THREE-PHASE PAD-MOUNTED TRANSFORMERS

IEEE C57.12.34, IEEE C57.12.28 and as specified herein. Submit manufacturer's information for each component, device, insulating fluid, and accessory provided with the transformer.

#### 2.2.1 Compartments

Provide high- and low-voltage compartments separated by steel isolating barriers extending the full height and depth of the compartments. Compartment doors: hinged lift-off type with stop in open position and three-point latching.

##### 2.2.1.1 High Voltage, Dead-Front

High-voltage compartment contains: the incoming line, insulated high-voltage load-break connectors, bushing well inserts, six high-voltage bushing wells configured for loop feed application, load-break switch handle(s), access to oil-immersed bayonet fuses, dead-front surge arresters, tap changer handle, connector parking stands with insulated standoff bushings, protective caps, and ground pad.

Minimum high-voltage compartment dimensions: IEEE C57.12.34, Figures 16 and 17.

- a. Insulated high-voltage load-break connectors: IEEE 386, rated 15 kV, 95 kV BIL. Current rating: 200 amperes rms continuous. Short time rating: 10,000 amperes rms symmetrical for a time duration of 0.17 seconds. Connector must have a steel reinforced hook-stick eye, grounding eye, test point, and arc-quenching contact material.

- b. Bushing well inserts: IEEE 386, 200 amperes, 15 kV Class. Provide a bushing well insert for each bushing well unless indicated otherwise.

- c. One-piece bushings: IEEE 386, 200 amperes, 15 kV Class.

- d. Load-break switch

Radial-feed two-position oil-immersed type rated at 15 kV, 95 kV BIL, with a continuous current rating and load-break rating of 200 amperes, and a make-and-latch rating of 12,000 rms amperes symmetrical. Locate the switch handle in the high-voltage compartment.

- e. Provide bayonet oil-immersed, expulsion fuses in series with oil-immersed, partial-range, current-limiting fuses. The bayonet fuse links sense both high currents and high oil temperature in order to provide thermal protection to the transformer. Coordinate transformer protection with expulsion fuse clearing low-current faults and

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current-limiting fuse clearing high-current faults beyond the interrupting rating of the expulsion fuse. Include an oil retention valve inside the bayonet assembly housing, which closes when the fuse holder is removed, and an external drip shield to minimize oil spills. Display a warning label adjacent to the bayonet fuse(s) cautioning against removing or inserting fuses unless the transformer has been de-energized and the tank pressure has been released.

Bayonet fuse assembly: 150 kV BIL.

Oil-immersed current-limiting fuses: IEEE C37.47; 50,000 rms amperes symmetrical interrupting rating at the system voltage specified. Connect current-limiting fuses ahead of the radial-feed load-break switch.

- f. Surge arresters: IEEE C62.11, rated 15 kV, fully shielded, dead-front, metal-oxide-varistor, elbow type with resistance-graded gap. Provide three arresters for radial feed circuits.
- g. Parking stands: Provide a parking stand near each bushing. Provide insulated standoff bushings for parking of energized high-voltage connectors on parking stands.
- h. Protective caps: IEEE 386, 200 amperes, 15 kV Class. Provide insulated protective caps (not shipping caps) for insulating and sealing out moisture from unused bushings.

#### 2.2.1.2 Low Voltage

Low-voltage compartment contains: low-voltage bushings with NEMA spade terminals, accessories, metering, stainless steel or laser-etched anodized aluminum diagrammatic transformer nameplate, and ground pad.

- a. Include the following accessories: drain valve with sampler device, fill plug, pressure relief device, liquid level gage, pressure-vacuum gage, and dial type thermometer with maximum temperature indicator.

#### **Amendment 0003\*\*\*\*\***

#### 2.2.2 Transformer

- a. Less-flammable bio-based liquid-insulated, two winding, 60 hertz, 65 degrees C rise above a 30 degrees C average ambient, self-cooled type.
- b. Transformer rated 750 kVA & 500 kVA refer to drawings.
- c. Transformer voltage ratings 750 kVA: 13,200 V Delta - 480 V GrdY.
- d. Transformer voltage ratings 500 kVA: 13,200 V Delta - 208 V GrdY
- e. Tap changer: externally operated, manual type for changing tap setting when the transformer is de-energized. Provide four 2.5 percent full capacity taps, two above and two below rated primary voltage. Indicate which tap setting is in use, clearly visible when the compartment is opened.
- f. Minimum tested percent impedance at 85 degrees C:
  - (1) .50 for units rated 75kVA and below

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- (2) .87 for units rated 112.5kVA to 300kVA
- (3) .30 for 500kVA rated units
- (4) .32 for units rated 750kVA and above

g. Comply with the following audible sound level limits:

| <u>kVA</u> | <u>DECIBELS</u><br>(MAX) |
|------------|--------------------------|
| 75         | 51                       |
| 112.5      | 55                       |
| 150        | 55                       |
| 225        | 55                       |
| 300        | 55                       |
| 500        | 56                       |
| 750        | 57                       |
| 1000       | 58                       |
| 1500       | 60                       |
| 2000       | 61                       |
| 2500       | 62                       |

h. Include:

- (1) Lifting lugs and provisions for jacking under base, with base construction suitable for using rollers or skidding in any direction.
- (2) An insulated low-voltage neutral bushing with NEMA spade terminal, and with removable ground strap.
- (3) Provide transformer top with an access handhole.
- (4) kVA rating conspicuously displayed on its enclosure.

\*\*\*\*\*Amendment 0003

#### 2.2.2.1 Specified Transformer Efficiencies

Provide transformer efficiency calculations utilizing the actual no-load and load loss values obtained during the routine tests performed on the actual transformer(s) prepared for this project. Reference no-load losses (NLL) at 20 degrees C. Reference load losses (LL) at 55 degrees C and at 50 percent of the nameplate load. The transformer is not acceptable if the calculated transformer efficiency is less than the efficiency indicated in the "KVA / Efficiency" table below. The table is based on requirements contained within 10 CFR 431, Subpart K. Submit certification, including supporting calculations, from the manufacturer indicating conformance.

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| <u>kVA</u> | <u>EFFICIENCY</u><br><u>(percent)</u> |
|------------|---------------------------------------|
| 15         | 98.65                                 |
| 30         | 98.83                                 |
| 45         | 98.92                                 |
| 75         | 99.03                                 |
| 112.5      | 99.11                                 |
| 150        | 99.16                                 |
| 225        | 99.23                                 |
| 300        | 99.27                                 |
| 500        | 99.35                                 |
| 750        | 99.40                                 |
| 1000       | 99.43                                 |
| 1500       | 99.48                                 |
| 2000       | 99.51                                 |
| 2500       | 99.53                                 |
| above 2500 | 99.54                                 |

### 2.2.3 Insulating Liquid

- a. Less-flammable transformer liquids: NFPA 70 and FM APP GUIDE for less-flammable liquids having a fire point not less than 300 degrees C tested per ASTM D92 and a dielectric strength not less than 33 kV tested per ASTM D877/D877M. Provide identification of transformer as "non-PCB" and "manufacturer's name and type of fluid" on the nameplate.

Provide a fluid that is a biodegradable, electrical insulating, and cooling liquid classified by UL and approved by FM as "less flammable" with the following properties:

- (1) Pour point: ASTM D97, less than -15 degree C
- (2) Aquatic biodegradation: EPA 712-C-98-075, ultimately biodegradable as designated by EPA.
- (3) Trout toxicity: OECD Test 203, zero mortality of EPA 821-R-02-012, pass

#### 2.2.3.1 Liquid-Filled Transformer Nameplates

Provide nameplate information in accordance with IEEE C57.12.00 and as modified or supplemented by this section.

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#### 2.2.4 Corrosion Protection

Provide corrosion resistant bases and cabinets of transformers, fabricated of stainless steel conforming to ASTM A240/A240M, Type 304 or 304L. Base includes any part of pad-mounted transformer that is within 3 inches of concrete pad.

Paint entire transformer assembly Munsell 7GY3.29/1.5 green, with paint coating system complying with IEEE C57.12.28 regardless of base, cabinet, and tank material. The Munsell color notation is specified in ASTM D1535.

#### 2.3 WARNING SIGNS AND LABELS

Provide warning signs for the enclosures of pad-mounted transformers having a nominal rating exceeding 600 volts in accordance with NEMA Z535.4 and NEMA 260.

- a. When the enclosure integrity of such equipment is specified to be in accordance with IEEE C57.12.28, such as for pad-mounted transformers, provide self-adhesive warning labels on the outside of the high voltage compartment door(s) with nominal dimensions of 7 by 10 inches with the legend "WARNING HIGH VOLTAGE" printed in two lines of nominal 2 inch high letters. Include the word "WARNING" in white letters on an orange background and the words "HIGH VOLTAGE" in black letters on a white background.

#### 2.4 ARC FLASH WARNING LABEL

Provide arc flash warning label for the enclosure of pad-mounted transformers. Locate this self-adhesive warning label on the outside of the high voltage compartment door warning of potential electrical arc flash hazards and appropriate PPE required. Provide label format as indicated.

#### 2.5 GROUNDING AND BONDING

UL 467. Provide grounding and bonding as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

#### 2.6 PADLOCKS

Provide padlocks for pad-mounted equipment, keyed as directed by the Contracting Officer. Comply with Section 08 71 00 DOOR HARDWARE.

#### 2.7 CAST-IN-PLACE CONCRETE

Provide concrete associated with electrical work for other than encasement of underground ducts rated for 4000 psi minimum 28-day compressive strength unless specified otherwise. Conform to the requirements of Section 03 30 00 CAST-IN-PLACE CONCRETE.

#### 2.8 SOURCE QUALITY CONTROL

##### 2.8.1 Transformer Test Schedule

The Government reserves the right to witness tests. Provide transformer test schedule for tests to be performed at the manufacturer's test facility. Submit required test schedule and location, and notify the Contracting Officer 30 calendar days before scheduled test date. Notify Contracting Officer 15 calendar days in advance of changes to scheduled

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date.

a. Test Instrument Calibration

- (1) Provide a calibration program which assures that all applicable test instruments are maintained within rated accuracy.
- (2) Accuracy: Traceable to the National Institute of Standards and Technology.
- (3) Instrument calibration frequency schedule: less than or equal to 12 months for both test floor instruments and leased specialty equipment.
- (4) Dated calibration labels: visible on all test equipment.
- (5) Calibrating standard: higher accuracy than that of the instrument tested.
- (6) Keep up-to-date records that indicate dates and test results of instruments calibrated or tested. For instruments calibrated by the manufacturer on a routine basis, in lieu of third party calibration, include the following:
  - (a) Maintain up-to-date instrument calibration instructions and procedures for each test instrument.
  - (b) Identify the third party/laboratory calibrated instrument to verify that calibrating standard is met.

2.8.2 Design Tests

IEEE C57.12.00, and IEEE C57.12.90. Section 5.1.2 in IEEE C57.12.80 states that "design tests are made only on representative apparatus of basically the same design." Submit design test reports (complete with test data, explanations, formulas, and results), in the same submittal package as the catalog data and drawings for each of the specified transformer(s), with design tests performed prior to the award of this contract.

- a. Tests: certified and signed by a registered professional engineer.
- b. Temperature rise: "Basically the same design" for the temperature rise test means a pad-mounted transformer with the same coil construction (such as wire wound primary and sheet wound secondary), the same kVA, the same cooling type (KNAN), the same temperature rise rating, and the same insulating liquid as the transformer specified.
- c. Lightning impulse: "Basically the same design" for the lightning impulse dielectric test means a pad-mounted transformer with the same BIL, the same coil construction (such as wire wound primary and sheet wound secondary), and a tap changer, if specified. Design lightning impulse tests includes the primary windings only of that transformer.
  - (1) IEEE C57.12.90, paragraph 10.3 entitled "Lightning Impulse Test Procedures," and IEEE C57.98.
  - (2) State test voltage levels.
  - (3) Provide photographs of oscilloscope display waveforms or plots of

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digitized waveforms with test report.

- d. Lifting and moving devices: "Basically the same design" requirement for the lifting and moving devices test means a test report confirming that the lifting device being used is capable of handling the weight of the specified transformer in accordance with IEEE C57.12.34.
- e. Pressure: "Basically the same design" for the pressure test means a pad-mounted transformer with a tank volume within 30 percent of the tank volume of the transformer specified.
- f. Short circuit: "Basically the same design" for the short circuit test means a pad-mounted transformer with the same kVA as the transformer specified.

### 2.8.3 Routine and Other Tests

IEEE C57.12.00. Routine and other tests: performed in accordance with IEEE C57.12.90 by the manufacturer on each of the actual transformer(s) prepared for this project to ensure that the design performance is maintained in production. Submit test reports, by serial number and receive approval before delivery of equipment to the project site. Required tests and testing sequence as follows:

- a. Phase relation
- b. Ratio
- c. No-load losses (NLL) and excitation current
- d. Load losses (LL) and impedance voltage
- e. Dielectric
  - (1) Impulse
  - (2) Applied voltage
  - (3) Induced voltage
- f. Leak

## PART 3 EXECUTION

### 3.1 INSTALLATION

Conform to IEEE C2, NFPA 70, and to the requirements specified herein. Provide new equipment and materials unless indicated or specified otherwise.

### 3.2 GROUNDING

NFPA 70 and IEEE C2, except provide grounding systems with a resistance to solid earth ground not exceeding 25 ohms.

#### 3.2.1 Grounding Electrodes

Provide driven ground rods as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION. Connect ground conductors to the upper end of ground rods by exothermic weld or compression connector. Provide

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compression connectors at equipment end of ground conductors.

### 3.2.2 Pad-Mounted Transformer Grounding

Provide a ground ring around the transformer with 1/0 AWG bare copper. Provide four ground rods in the ground ring, one per corner. Install the ground rods at least 10 feet apart from each other. Provide separate copper grounding conductors and connect them to the ground loop 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" applies.

### 3.2.3 Connections

Make joints in grounding conductors and loops by exothermic weld or compression connector. Install exothermic welds and compression connectors as specified in Section 33 71 02 UNDERGROUND ELECTRICAL DISTRIBUTION.

### 3.2.4 Grounding and Bonding Equipment

UL 467, except as indicated or specified otherwise.

## 3.3 INSTALLATION OF EQUIPMENT AND ASSEMBLIES

Install and connect pad-mounted transformers furnished under this section as indicated on project drawings, the approved shop drawings, and as specified herein.

### 3.3.1 Meters and Current Transformers

ANSI C12.1.

## 3.4 FIELD APPLIED PAINTING

Where field painting of enclosures is required to correct damage to the manufacturer's factory applied coatings, provide manufacturer's recommended coatings and apply in accordance with manufacturer's instructions.

## 3.5 NOT USED

## 3.6 FOUNDATION FOR EQUIPMENT AND ASSEMBLIES

Mount transformer on concrete slab as follows:

- a. Unless otherwise indicated, provide the slab with dimensions at least 8 inches thick, reinforced with a 6 by 6 inches - W2.9 by W2.9 mesh placed uniformly 4 inches from the top of the slab.
- b. Place slab on a 6 inch thick, well-compacted gravel base.
- c. Install slab such that top of concrete slab is approximately 4 inches above the finished grade with gradual slope for drainage.
- d. Provide edges above grade with 1/2 inch chamfer.
- e. Provide slab of adequate size to project at least 8 inches beyond the equipment.

Stub up conduits, with bushings, 2 inches into cable wells in the concrete

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pad. Coordinate dimensions of cable wells with transformer cable training areas.

### 3.6.1 Cast-In-Place Concrete

Provide cast-in-place concrete work in accordance with the requirements of Section 03 30 00 CAST-IN-PLACE CONCRETE ACI 318.

### 3.6.2 Sealing

When the installation is complete, seal all entries into the equipment enclosure with an approved sealing method. Provide seals of sufficient strength and durability to protect all energized live parts of the equipment from rodents, insects, or other foreign matter.

## 3.7 FIELD QUALITY CONTROL

### 3.7.1 Performance of 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. Submit reports, including acceptance criteria and limits for each test in accordance with NETA ATS "Test Values".

#### 3.7.1.1 Pad-Mounted Transformers

##### a. Visual and mechanical inspection

- (1) Compare equipment nameplate data with specifications and approved shop drawings.
- (2) Inspect physical and mechanical condition. Check for damaged or cracked insulators and leaks.
- (3) Inspect anchorage, alignment, and grounding.
- (4) Verify the presence of PCB content labeling.
- (5) Verify the bushings and transformer interiors are clean.
- (6) Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey.
- (7) Verify correct liquid level in tanks and bushings.
- (8) Verify that positive pressure is maintained on gas-blanketed transformers.
- (9) Perform specific inspections and mechanical tests as recommended by manufacturer.
- (10) Verify de-energized tap changer position is left as specified.
- (11) Verify the presence of transformer surge arresters.

##### b. Electrical tests

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- (1) Perform resistance measurements through all bolted connections with low-resistance ohmmeter.
- (2) Verify proper secondary voltage phase-to-phase and phase-to-neutral after energization and prior to loading.
- (3) Perform insulation-resistance tests, winding-to-winding and each winding-to-ground. Calculate polarization index. Verify that the tap changer is set at the specified ratio.
- (4) Perform turns-ratio tests at all tap positions.
- (5) Perform insulation power-factor or dissipation-factor tests on all windings in accordance with test equipment manufacturer's published data.
- (6) Perform power-factor or dissipation-factor tests on each bushing equipped with a power-factor/capacitance tap. In the absence of a power-factor/capacitance tap, perform hot-collar tests.
- (7) Measure the resistance of each high-voltage winding in each de-energized tap-changer position. Measure the resistance of each low-voltage winding in each de-energized tap-changer position, if applicable.
- (8) Remove and test a sample of insulating liquid for the following: Dielectric breakdown voltage, Acid neutralization number, Specific gravity, Interfacial tension, Color, Visual Condition, Water in insulating liquids (Required on 25 kV or higher voltages and on all silicone-filled units.), and Power factor or dissipation factor.
- (9) Perform dissolved-gas analysis (DGA) on a sample of insulating liquid.

#### 3.7.1.2 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 wiring.
- (5) Verify the unit is clean.
- (6) Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey.
- (7) Verify that all required grounding and shorting connections provide good contact.

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- (8) Verify correct operation of transformer withdrawal mechanism and grounding operation.
- (9) Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.

b. Electrical tests

- (1) Perform resistance measurements through all bolted connections with low-resistance ohmmeter, if applicable.
- (2) Perform insulation-resistance test.
- (3) Perform a polarity test.
- (4) Perform a ratio-verification test.

3.7.1.3 Watthour Meter

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) Calibrate watthour meters according to manufacturer's published data.
- (2) Verify that correct multiplier has been placed on face of meter, where applicable.
- (3) Verify that current transformer secondary circuits are intact.

3.7.1.4 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 resistance tester in accordance with manufacturer's instructions to test each ground or group of grounds. Use an instrument 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.

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- (2) Submit the measured ground resistance of each ground rod and grounding system, indicating the location of the rod and grounding system. Include the test method and test setup (i.e., pin location) used to determine ground resistance and soil conditions at the time the measurements were made.

#### 3.7.1.5 Surge Arresters, Medium- and High-Voltage

##### a. Visual and mechanical inspection

- (1) Compare equipment nameplate data with specifications and approved shop drawings.
- (2) Inspect physical and mechanical condition.
- (3) Inspect anchorage, alignment, grounding, and clearances.
- (4) Verify the arresters are clean.
- (5) Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey.
- (6) Verify that the ground lead on each device is individually attached to a ground bus or ground electrode.

##### b. Electrical tests

- (1) Perform resistance measurements through all bolted connections with low-resistance ohmmeter, if applicable.
- (2) Perform an insulation-resistance test on each arrester, phase terminal-to-ground.
- (3) Test grounding connection.

#### 3.7.2 Follow-Up Verification

Upon completion of acceptance checks and tests, show by demonstration in service that circuits and devices are in good operating condition and properly performing the intended function. As an exception to requirements stated elsewhere in the contract, notify the Contracting Officer 5 working days in advance of the dates and times of checking and testing.

-- End of Section --

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## SECTION 33 71 02

## UNDERGROUND ELECTRICAL DISTRIBUTION

**02/26, CHG 1: 05/26****Amendment 0003**

## 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.

## ASSOCIATION OF EDISON ILLUMINATING COMPANIES (AEIC)

AEIC CS8 (2013) Specification for Extruded  
Dielectric Shielded Power Cables Rated 5  
Through 46 kV

## ASTM INTERNATIONAL (ASTM)

ASTM B1 (2013) Standard Specification for  
Hard-Drawn Copper Wire

ASTM B8 (2023) Standard Specification for  
Concentric-Lay-Stranded Copper Conductors,  
Hard, Medium-Hard, or Soft

ASTM B231/B231M (2023) Standard Specification for  
Concentric-Lay-Stranded Aluminum 1350  
Conductors

ASTM B400/B400M (2023) Standard Specification for Compact  
Round Concentric-Lay-Stranded Aluminum  
1350 Conductors

ASTM B609/B609M (2012; R 2021) Standard Specification for  
Aluminum 1350 Round Wire, Annealed and  
Intermediate Tempers, for Electrical  
purposes

ASTM B800 (2005; R 2021) Standard Specification for  
8000 Series Aluminum Alloy Wire for  
Electrical Purposes-Annealed and  
Intermediate Tempers

ASTM B801 (2018; R 2023) Standard Specification for  
Concentric-Lay-Stranded Conductors of 8000  
Series Aluminum Alloy for Subsequent  
Covering or Insulation

ASTM F512 (2025) Standard Specification for  
Smooth-Wall Poly (Vinyl Chloride) (PVC)  
Conduit and Fittings for Underground  
Installation

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#### INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

|                      |                                                                                               |
|----------------------|-----------------------------------------------------------------------------------------------|
| IEEE 81              | (2025) IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth                |
| IEEE 400.2           | (2024) Guide for Field Testing of Shielded Power Cable Systems Using Very Low Frequency (VLF) |
| IEEE C2              | (2023; ERTA 1 2023; ERTA 2-3 2025)<br>National Electrical Safety Code                         |
| IEEE Stds Dictionary | (2009) IEEE Standards Dictionary: Glossary of Terms & Definitions                             |

#### INSULATED CABLE ENGINEERS ASSOCIATION (ICEA)

|               |                                                        |
|---------------|--------------------------------------------------------|
| ICEA S-94-649 | (2021) Concentric Neutral Cables Rated 5 Through 46 KV |
|---------------|--------------------------------------------------------|

#### INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

|          |                                                                                                  |
|----------|--------------------------------------------------------------------------------------------------|
| NETA ATS | (2025) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems |
|----------|--------------------------------------------------------------------------------------------------|

#### NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

|                               |                                                                                                                     |
|-------------------------------|---------------------------------------------------------------------------------------------------------------------|
| ANSI/NEMA WC 71/ICEA S-96-659 | (2014; R 2022) Standard for Nonshielded Cables Rated 2001-5000 Volts for use in the Distribution of Electric Energy |
| NEMA RN 1                     | (2018) Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit     |
| NEMA TC 2                     | (2020) Standard for Electrical Polyvinyl Chloride (PVC) Conduit                                                     |
| NEMA TC 6 & 8                 | (2020) Standard for Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installations                   |
| NEMA TC 9                     | (2020) Standard for Fittings for Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installation       |
| NEMA WC 74/ICEA S-93-639      | (2022) 5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy                 |

#### NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

|         |                                                                                                                                        |
|---------|----------------------------------------------------------------------------------------------------------------------------------------|
| NFPA 70 | (2026; TIA 26-1; ERTA 26-1; TIA 26-2; TIA 26-3; TIA 26-4; TIA 26-5; TIA 26-6; TIA 26-7; ERTA 26-2; ERTA 26-3) National Electrical Code |
|---------|----------------------------------------------------------------------------------------------------------------------------------------|

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TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA-758 (2012b) Customer-Owned Outside Plant  
Telecommunications Infrastructure Standard

U.S. DEPARTMENT OF AGRICULTURE (USDA)

RUS Bull 1751F-644 (2002) Underground Plant Construction

UL SOLUTIONS (UL)

UL 6 (2022) UL Standard for Safety Electrical  
Rigid Metal Conduit-Steel

UL 94 (2023; Reprint Feb 2026) UL Standard for  
Safety Tests for Flammability of Plastic  
Materials for Parts in Devices and  
Appliances

UL 467 (2022) UL Standard for Safety Grounding  
and Bonding Equipment

UL 510 (2020; Dec 2022) UL Standard for Safety  
Polyvinyl Chloride, Polyethylene and  
Rubber Insulating Tape

UL 514B (2012; Reprint Mar 2024) UL Standard for  
Safety Conduit, Tubing and Cable Fittings

UL 651 (2011; Reprint Apr 2026) UL Standard for  
Safety Schedule 40, 80, Type EB and A  
Rigid PVC Conduit and Fittings

UL 1072 (2006; Reprint Oct 2024) Medium-Voltage  
Power Cables

UL 1242 (2025) UL Standard for Safety for  
Electrical Intermediate Metal Conduit -  
Steel

## 1.2 RELATED REQUIREMENTS

Section 26 08 00 APPARATUS INSPECTION AND TESTING applies to this section,  
with the additions and modifications specified herein.

## 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 Stds Dictionary.
- b. In the text of this section, the words conduit and duct are used interchangeably and have the same meaning.
- c. In the text of this section, "medium voltage cable splices," and "medium voltage cable joints" are used interchangeably and have the same meaning.

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#### 1.4 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

##### SD-02 Shop Drawings

Aluminum Conductors;

Precast Underground Structures;

##### SD-03 Product Data

Medium Voltage Cable;

Medium Voltage Cable Terminations;

Sealing Material

Pulling-In Irons

Cable Supports (racks, arms and insulators);

##### SD-06 Test Reports

Medium Voltage Cable Qualification and Production Tests;

Field Acceptance Checks and Tests;

Arc-proofing Test for cable fireproofing tape;

##### SD-07 Certificates

Cable splicer/terminator;

Cable Installer Qualifications;

#### 1.5 QUALITY ASSURANCE

##### 1.5.1 Certificate of Competency for Cable Splicer/Terminator

The cable splicer/terminator must have a certification from the National Cable Splicing Certification Board (NCSCB) in the field of splicing and terminating shielded medium voltage (5 kV to 35 kV) power cable using pre-manufactured kits (pre-molded, heat-shrink, cold shrink). Submit "Proof of Certification" for approval, for the individuals that will be performing cable splicer and termination work, 30 days before splices or terminations are to be made.

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#### 1.5.2 Cable Installer Qualifications

Provide at least one onsite person in a supervisory position with a documentable level of competency and experience to supervise all cable pulling operations. Provide a resume showing the cable installers' experience in the last three years, including a list of references complete with points of contact, addresses and telephone numbers. Cable installer must demonstrate experience with a minimum of three medium voltage cable installations. The Contracting Officer reserves the right to require additional proof of competency or to reject the individual and call for an alternate qualified cable installer.

#### 1.5.3 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "must" 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 must be in accordance with the mandatory and advisory provisions of IEEE C2 and NFPA 70 unless more stringent requirements are specified or indicated.

#### 1.5.4 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 must have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period must include applications of equipment and materials under similar circumstances and of similar size. The product must have been for 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 must 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.

##### 1.5.4.1 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.

##### 1.5.4.2 Material and Equipment Manufacturing Date

Products manufactured more than 3 years prior to date of delivery to site are not acceptable, unless specified otherwise.

## PART 2 PRODUCTS

### 2.1 CONDUIT, DUCTS, AND FITTINGS

#### 2.1.1 Rigid Metal Conduit

UL 6.

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#### 2.1.1.1 Rigid Metallic Conduit, PVC Coated

NEMA RN 1, Type A40, except that hardness must be nominal 85 Shore A durometer, dielectric strength must be minimum 400 volts per mil at 60 Hz, and tensile strength must be minimum 3500 psi.

#### 2.1.1.2 Intermediate Metal Conduit

UL 1242.

#### 2.1.1.1 Intermediate Metal Conduit, PVC Coated

NEMA RN 1, Type A40, except that hardness must be nominal 85 Shore A durometer, dielectric strength must be minimum 400 volts per mil at 60 Hz, and tensile strength must be minimum 3500 psi.

#### 2.1.1.3 Plastic Conduit for Direct Burial and Riser Applications

UL 651 and NEMA TC 2, EPC-40.

#### 2.1.1.4 Plastic Duct for Concrete Encasement

Provide Type EB-20 in accordance with UL 651, ASTM F512, and NEMA TC 6 & 8 or Type EPC-40 in accordance with UL 651 and NEMA TC 2.

#### 2.1.1.5 Duct Sealant

UL 94, Class HBF. Provide high-expansion urethane foam duct sealant that expands and hardens to form a closed, chemically and water resistant, rigid structure. Sealant must be compatible with common cable and wire jackets and capable of adhering to metals, plastics and concrete. Sealant must be capable of curing in temperature ranges of 35 degrees F to 95 degrees F. Cured sealant must withstand temperature ranges of -20 degrees F to 200 degrees F without loss of function.

#### 2.1.1.6 Fittings

##### 2.1.1.6.1 Metal Fittings

UL 514B.

##### 2.1.1.6.2 PVC Conduit Fittings

UL 514B, UL 651.

##### 2.1.1.6.3 PVC Duct Fittings

NEMA TC 9.

#### 2.2 NOT USED

#### 2.3 NOTE USED2.4 MEDIUM VOLTAGE CABLE

Cable (conductor) sizes are designated by American Wire Gauge (AWG) and Thousand Circular Mils (Kcmil). Conductor and conduit sizes indicated are for copper conductors unless otherwise noted. Insulated conductors must have the date of manufacture and other identification imprinted on the outer surface of each cable at regular intervals throughout cable length. Wires and cables manufactured more than 24 months prior to date of delivery

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to the site are not acceptable. Provide single conductor type cables unless otherwise indicated.

#### 2.4.1 Cable Configuration

Provide Type MV cable, conforming to NEMA WC 74/ICEA S-93-639 and UL 1072. Provide cables manufactured for use in duct applications. Cable must be rated 15 kV with 133 percent insulation level.

#### 2.4.2 Conductor Material

Provide concentric-lay-stranded, Class B conductors. Provide aluminum alloy Type AA-8000 aluminum conductors complying with ASTM B800 and ASTM B801 aluminum alloy 1350 cables, 3/4 hard minimum complying with ASTM B609/B609M and ASTM B231/B231M for regular concentric and compressed stranding or ASTM B400/B400M for compacted stranding.

#### 2.4.3 Insulation

Provide ethylene-propylene-rubber (EPR) insulation conforming to the requirements of ANSI/NEMA WC 71/ICEA S-96-659 and AEIC CS8/ICEA S-94-649.

#### 2.4.4 Shielding

Cables rated for 2 kV and above must have a semiconducting conductor shield, a semiconducting insulation shield, and an overall copper tape shield for each phase.

#### 2.4.5 Neutrals

Neutral conductors must be copper, employing the same insulation and jacket materials as phase conductors, except that a 600-volt insulation rating is acceptable.

#### 2.4.6 Jackets

Provide cables with a PVC jacket.

#### 2.5 NOT USED

#### 2.6 NOT USED

#### 2.7 NOT USED

#### 2.8 NOT USED

#### 2.9 TAPE

##### 2.9.1 Insulating Tape

UL 510, plastic insulating tape, capable of performing in a continuous temperature environment of 80 degrees C.

##### 2.9.2 Buried Warning and Identification Tape

Provide detectable tape in accordance with Section 31 00 00 EARTHWORK.

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### 2.9.3 Fireproofing Tape

Provide tape composed of a flexible, conformable, unsupported intumescent elastomer. Tape must be not less than .030 inch thick, noncorrosive to cable sheath, self-extinguishing, noncombustible, adhesive-free, and must not deteriorate when subjected to oil, water, gases, salt water, sewage, and fungus.

### 2.10 PULL ROPE

Plastic or flat pull line (bull line) having a minimum tensile strength of 200 pounds.

### 2.11 GROUNDING AND BONDING

#### 2.11.1 Driven Ground Rods

Provide solid copper ground rods conforming to UL 467 not less than 3/4 inch in diameter by 10 feet in length. Sectional type rods may be used for rods 20 feet or longer.

#### 2.11.2 Grounding Conductors

Stranded-bare copper conductors must conform to ASTM B8, Class B, soft-drawn unless otherwise indicated. Solid-bare copper conductors must conform to ASTM B1 for sizes No. 8 and smaller. Insulated conductors must be of the same material as phase conductors and green color-coded, except that conductors must be rated no more than 600 volts. Aluminum is not acceptable.

### 2.12 CAST-IN-PLACE CONCRETE

Provide concrete in accordance with Section 03 30 00 CAST-IN-PLACE CONCRETE. In addition, provide concrete for encasement of underground ducts with 3000 psi minimum 28-day compressive strength. Concrete associated with electrical work for other than encasement of underground ducts must be 4000 psi minimum 28-day compressive strength unless specified otherwise.

### 2.13 NOT USED

#### 2.13.1 2.14 CABLE SUPPORTS (RACKS, ARMS, AND INSULATORS)

Zinc coat the metal portion of racks and arms after fabrication.

#### 2.14.1 Cable Rack Stanchions

The wall bracket or stanchion must be 4 inches by approximately 1-1/2 inch by 3/16 inch channel steel, or 4 inches by approximately 1 inch glass-reinforced nylon with recessed bolt mounting holes, 48 inches long (minimum) in manholes. Space slots for mounting cable rack arms at 8 inch intervals.

#### 2.14.2 Rack Arms

Cable rack arms must be steel or malleable iron or glass reinforced nylon and must be of the removable type. Rack arm length must be a minimum of 8

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inches and a maximum of 12 inches.

#### 2.14.3 Insulators

Insulators for metal rack arms must be dry-process glazed porcelain. Insulators are not required for nylon arms.

2.15 NOT USED

2.16 NOT USED

2.17 NOT USED

#### 2.18 SOURCE QUALITY CONTROL

##### 2.18.1 Arc-Proofing Test for Cable Fireproofing Tape

Manufacturer must test one sample assembly consisting of a straight lead tube 12 inches long with a 2 1/2 inch outside diameter, and a 1/8 inch thick wall, and covered with one-half lap layer of arc and fireproofing tape in accordance with manufacturer's instructions. The arc and fireproofing tape must withstand extreme temperature of a high-current fault arc 13,000 degrees K for 70 cycles as determined by using an argon directed plasma jet capable of constantly producing and maintaining an arc temperature of 13,000 degrees K. Temperature (13,000 degrees K) of the ignited arc between the cathode and anode must be obtained from a dc power source of 305 (plus or minus 5) amperes and 20 (plus or minus 1) volts. Direct the arc toward the sample assembly accurately positioned 5 (plus or minus 1) millimeters downstream in the plasma from the anode orifice by fixed flow rate of argon gas (0.18 g per second). Test each sample assembly at three unrelated points. Start time for tests must be taken from recorded peak current when the specimen is exposed to the full test temperature. Surface heat on the specimen prior to that time must be minimal. The end point is established when the plasma or conductive arc penetrates the protective tape and strikes the lead tube. Submittals for arc-proofing tape must indicate that the test has been performed and passed by the manufacturer.

##### 2.18.2 Medium Voltage Cable Qualification and Production Tests

Results of AEIC CS8 qualification and production tests as applicable for each type of medium voltage cable.

### PART 3 EXECUTION

#### 3.1 INSTALLATION

Install equipment and devices in accordance with the manufacturer's published instructions and with the requirements and recommendations of NFPA 70 and IEEE C2] as applicable. In addition to these requirements, install telecommunications in accordance with TIA-758 and RUS Bull 1751F-644.

#### 3.2 CABLE INSPECTION

Inspect each cable reel for correct storage positions, signs of physical damage, and broken end seals prior to installation. If end seal is broken,

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remove moisture from cable prior to installation in accordance with the cable manufacturer's recommendations.

### 3.3 UNDERGROUND FEEDERS SUPPLYING BUILDINGS

Terminate underground feeders supplying building at a point 5 feet outside the building and projections thereof, except that conductors must be continuous to the terminating point indicated. Coordinate connections of the feeders to the service entrance equipment with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide PVC, Type EPC-40 conduit from the supply equipment to a point 5 feet outside the building and projections thereof. Protect ends of underground conduit with plastic plugs until connections are made.

Encase the underground portion of the conduit in a concrete envelope and bury as specified for underground duct with concrete encasement.

### 3.4 NOT USED

### 3.5 UNDERGROUND CONDUIT AND DUCT SYSTEMS

#### 3.5.1 Requirements

Run conduit in straight lines except where a change of direction is necessary. Provide numbers and sizes of ducts as indicated. Provide a 4/0 AWG bare copper grounding conductor below medium-voltage distribution duct banks. Bond bare copper grounding conductor to ground rings (loops) in all manholes and to ground rings (loops) at all equipment slabs (pads). Route grounding conductor into manholes with the duct bank (sleeving is not required). Ducts must have a continuous slope downward toward underground structures and away from buildings, laid with a minimum slope of 3 inches per 100 feet. Depending on the contour of the finished grade, the high-point may be at a terminal, a manhole, a handhole, or between manholes or handholes. Terminate all PVC conduit end points in utility holes, switching cabinets, transform handholes and buildings with end bells. The bell end of the conduits that enter manholes and handholes must be flush with the wall.

Perform changes in ductbank direction as follows:

- a. Short-radius manufactured 90-degree duct bends may be used only for pole or equipment risers, unless specifically indicated as acceptable.
- b. The minimum manufactured bend radius must be 18 inches for ducts of less than 3 inch diameter, and 36 inches for ducts 3 inches or greater in diameter.
- c. As an exception to the bend radius required above, provide field manufactured longsweep bends having a minimum radius of 25 feet for a change of direction of more than 5 degrees, either horizontally or vertically, using a combination of curved and straight sections. Maximum manufactured curved sections allowed for use in field manufactured longsweep bend: 30 degrees.

#### 3.5.2 Treatment

Keep ducts clean of concrete, dirt, or foreign substances during construction. Make field cuts requiring tapers with proper tools and match factory tapers. Use a coupling recommended by the duct manufacturer

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whenever an existing duct is connected to a duct of different material or shape. Store ducts to avoid warping and deterioration with ends sufficiently plugged to prevent entry of any water or solid substances. Thoroughly clean ducts before being laid. Store plastic ducts on a flat surface and protected from the direct rays of the sun.

### 3.5.3 Conduit Cleaning

As each conduit run is completed, for conduit sizes 3 inches and larger, draw a flexible testing mandrel approximately 12 inches long with a diameter less than the inside diameter of the conduit through the conduit. After which, draw a stiff bristle brush through until conduit is clear of particles of earth, sand and gravel; then immediately install conduit plugs. For conduit sizes less than 3 inches, draw a stiff bristle brush through until conduit is clear of particles of earth, sand and gravel; then immediately install conduit plugs.

### 3.5.4 Jacking and Drilling Under Roads and Structures

Conduits to be installed under existing paved areas which are not to be disturbed, and under roads and railroad tracks, must be zinc-coated, rigid steel, jacked into place. Where ducts are jacked under existing pavement, install rigid steel conduit because of its strength. To protect the corrosion-resistant conduit coating, predrilling or installing conduit inside a larger iron pipe sleeve (jack-and-sleeve) is required. For crossings of existing railroads and airfield pavements greater than 50 feet in length, the predrilling method or the jack-and-sleeve method will be used. Separators or spacing blocks must be made of steel, concrete, plastic, or a combination of these materials placed not farther apart than 4 feet on centers.

### 3.5.5 Multiple Conduits

Separate multiple conduits by a minimum distance of 3 inches. Stagger the joints of the conduits by rows (horizontally) and layers (vertically) to strengthen the conduit assembly. Provide plastic duct spacers that interlock vertically and horizontally. Spacer assembly must consist of base spacers, intermediate spacers, ties, and locking device on top to provide a completely enclosed and locked-in conduit assembly. Install spacers in accordance with manufacturer's instructions, but provide a minimum of two spacer assemblies per 10 feet of conduit assembly.

### 3.5.6 Conduit Plugs and Pull Rope

Provide new conduit indicated as being unused or empty with plugs on each end. Plugs must contain a weephole or screen to allow water drainage. Provide a plastic pull rope having 3 feet of slack at each end of unused or empty conduits.

### 3.5.7 Conduit and Duct Without Concrete Encasement

Depths to top of the conduit must be not less than 24 inches below finished grade. Provide not less than 3 inches clearance from the conduit to each side of the trench. Grade bottom of trench smooth; where rock, soft spots, or sharp-edged materials are encountered, excavate the bottom for an additional 3 inches, fill and tamp level with original bottom with sand or earth free from particles, that would be retained on a 1/4 inch sieve. The first 6 inch layer of backfill cover must be sand compacted as previously specified. The rest of the excavation must be backfilled and compacted in

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3 to 6 inch layers. Provide color, type and depth of warning tape as specified in Section 31 00 00 EARTHWORK.

#### 3.5.7.1 Encasement Under Roads and Structures

Under roads, paved areas, and railroad tracks, install conduits in concrete encasement of rectangular cross-section providing a minimum of 3 inch concrete cover around ducts. Extend concrete encasement at least 5 feet beyond the edges of paved areas and roads, and 12 feet beyond the rails on each side of railroad tracks. Depths to top of the concrete envelope must be not less than 24 inches below finished grade.

#### 3.5.8 Duct Encased in Concrete

Construct underground duct lines of individual conduits encased in concrete. Depths to top of the concrete envelope must be not less than 18 inches below finished grade, except under roads and pavement, concrete envelope must be not less than 24 inches below finished grade. Do not mix different kinds of conduit in any one duct bank. Concrete encasement surrounding the bank must be rectangular in cross-section and provide at least 3 inches of concrete cover for ducts. Separate conduits by a minimum concrete thickness of 3 inches. Before pouring concrete, anchor duct bank assemblies, prevent floating during concrete pouring by driving reinforcing rods adjacent to duct spacer assemblies and attaching the rods to the spacer assembly.

##### 3.5.8.1 Connections to Existing Ducts

Where connections to existing duct banks are indicated, excavate the banks to the maximum depth necessary. Cut off the banks and remove loose concrete from the conduits before new concrete-encased ducts are installed. Provide a reinforced concrete collar, poured monolithically with the new duct bank, to take the shear at the joint of the duct banks.

##### 3.5.8.2 Partially Completed Duct Banks

During construction wherever a construction joint is necessary in a duct bank, prevent debris such as mud, and, and dirt from entering ducts by providing suitable conduit plugs. Fit concrete envelope of a partially completed duct bank with reinforcing steel extending a minimum of 2 feet back into the envelope and a minimum of 2 feet beyond the end of the envelope. Provide one No. 4 bar in each corner, 3 inches from the edge of the envelope. Secure corner bars with two No. 3 ties, spaced approximately one foot apart. Restrain reinforcing assembly from moving during concrete pouring.

#### 3.5.9 Duct Sealing

Seal all electrical penetrations for radon mitigation, maintaining integrity of the vapor barrier, and to prevent infiltration of air, insects, and vermin.

### 3.6 CABLE PULLING

Test existing duct lines with a mandrel and thoroughly swab out to remove foreign material before pulling cables. Pull cables down grade with the feed-in point at the manhole or buildings of the highest elevation. Use flexible cable feeds to convey cables through manhole opening and into duct runs. Do not exceed the specified cable bending radii when installing

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cable under any conditions, including turnups into switches, transformers, switchgear, switchboards, and other enclosures. Cable with shield must have a bending radius not less than 12 times the overall diameter of the completed cable. If basket-grip type cable-pulling devices are used to pull cable in place, cut off the section of cable under the grip before splicing and terminating.

### 3.6.1 Cable Lubricants

Use lubricants that are specifically recommended by the cable manufacturer for assisting in pulling jacketed cables.

### 3.7 NOT USED

### 3.8 CONDUCTORS INSTALLED IN PARALLEL

Group conductors such that each conduit of a parallel run contains one Phase A conductor, one Phase B conductor, one Phase C conductor, and one neutral conductor.

### 3.9 LOW VOLTAGE CABLE SPLICING AND TERMINATING

Make terminations and splices with materials and methods as indicated or specified herein and as designated by the written instructions of the manufacturer. Do not allow the cables to be moved until after the splicing material has completely set.

#### 3.9.1 Terminating Aluminum Conductors

- a. Use particular care in making up joints and terminations. Remove surface oxides by cleaning with a wire brush or emery cloth. Apply joint compound to conductors, and use UL-listed solid aluminum connectors for connecting aluminum conductors. When connecting aluminum to copper conductors, use connectors specifically designed for this purpose.
- b. Terminate aluminum conductors to copper bus either by: (1) in line splicing a copper pigtail to the aluminum conductor (copper pigtail must have a ampacity at least that of the aluminum conductor); or (2) using a circumferential compression type, aluminum bodied terminal lug UL listed for AL/CU and steel Belleville spring washers, flat washers, bolts, and nuts. Belleville spring washers must be cadmium-plated hardened steel. Install the Belleville spring washers with the crown up toward the nut or bolt head, with the concave side of the Belleville bearing on a heavy-duty, wide series flat washer of larger diameter than the Belleville. Tighten nuts sufficient to flatten Belleville and leave in that position. Lubricate hardware with joint compound prior to making connection. Wire brush and apply joint compound to conductor prior to inserting in lug.
- c. Terminate aluminum conductors to aluminum bus by using all-aluminum nuts, bolts, washers, and lugs. Wire brush and apply inhibiting compound to conductor prior to inserting in lug. Lubricate hardware with joint compound prior to making connection; if bus contact surface is unplated, scratch-brush and coat with joint compound (without grit).

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### 3.10 MEDIUM VOLTAGE CABLE TERMINATIONS

Make terminations in accordance with the written instruction of the termination kit manufacturer.

### 3.11 MEDIUM VOLTAGE CABLE JOINTS

Provide power cable joints (splices) suitable for continuous immersion in water. Make joints only in accessible locations in manholes or handholes by using materials and methods in accordance with the written instructions of the joint kit manufacturer.

#### 3.11.1 Joints in Shielded Cables

Cover the joined area with metallic tape, or material like the original cable shield and connect it to the cable shield on each side of the splice. Provide a bare copper ground connection brought out in a watertight manner and grounded to the manhole grounding loop as part of the splice installation. Ground conductors, connections, and rods must be as specified elsewhere in this section. Wire must be trained to the sides of the enclosure to prevent interference with the working area.

### 3.12 CABLE END CAPS

Cable ends must be sealed at all times with coated heat shrinkable end caps. Cables ends must be sealed when the cable is delivered to the job site, while the cable is stored and during installation of the cable. The caps must remain in place until the cable is spliced or terminated. Sealing compounds and tape are not acceptable substitutes for heat shrinkable end caps. Cable which is not sealed in the specified manner at all times will be rejected.

### 3.13 NOT USED

### 3.14 FIREPROOFING OF CABLES IN UNDERGROUND STRUCTURES

Fireproof (arc proof) wire and cables which will carry current at 2200 volts or more in underground structures.

#### 3.14.1 Fireproofing Tape

Tightly wrap strips of fireproofing tape around each cable spirally in half-lapped wrapping. Install tape in accordance with manufacturer's instructions.

### 3.15 GROUNDING SYSTEMS

NFPA 70 and IEEE C2, except provide grounding systems with a resistance to solid earth ground not exceeding 25ohms.

#### 3.15.1 Grounding Electrodes

Provide cone pointed driven ground rods driven full depth plus 6 inches, installed to provide an earth ground of the appropriate value for the particular equipment being grounded.

If the specified ground resistance is not met, provide an additional ground rod in accordance with the requirements of NFPA 70 (placed not less than 6

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feet from the first rod). Should the resultant (combined) resistance exceed the specified resistance, measured not less than 48 hours after rainfall, notify the Contracting Officer immediately.

### 3.15.2 Grounding Connections

Make grounding connections which are buried or otherwise normally inaccessible, 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 must be as recommended by the manufacturer. An embossing die code or other standard method must provide visible indication that a connector has been adequately compressed on the ground wire.

### 3.15.3 Grounding Conductors

Provide bare grounding conductors, except where installed in conduit with associated phase conductors. Ground cable sheaths, cable shields, conduit, and equipment with No. 6 AWG. Ground other noncurrent-carrying metal parts and equipment frames of metal-enclosed equipment. Ground metallic frames and covers of handholes and pull boxes with a braided, copper ground strap with equivalent ampacity of No. 6 AWG.

### 3.15.4 Ground Cable Crossing Expansion Joints

Protect ground cables crossing expansion joints or similar separations in structures and pavements by use of approved devices or methods of installation which provide the necessary slack in the cable across the joint to permit movement. Use stranded or other approved flexible copper cable across such separations.

## 3.16 EXCAVATING, BACKFILLING, AND COMPACTING

Provide in accordance with NFPA 70.

### 3.16.1 Reconditioning of Surfaces

#### 3.16.1.1 Unpaved Surfaces

Restore to their original elevation and condition unpaved surfaces disturbed during installation of duct. Preserve sod and topsoil removed during excavation and reinstall after backfilling is completed. Replace sod that is damaged by sod of quality equal to that removed. When the surface is disturbed in a newly seeded area, re-seed the restored surface with the same quantity and formula of seed as that used in the original seeding, and provide topsoiling, fertilizing, liming, seeding, sodding, sprigging, or mulching.

#### 3.16.1.2 Paving Repairs

Where trenches, pits, or other excavations are made in existing roadways and other areas of pavement where surface treatment of any kind exists, restore such surface treatment or pavement the same thickness and in the

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same kind as previously existed, except as otherwise specified, and to match and tie into the adjacent and surrounding existing surfaces.

### 3.17 CAST-IN-PLACE CONCRETE

Provide concrete in accordance with Section 03 30 00 CAST-IN-PLACE CONCRETE.

#### 3.17.1 Concrete Slabs (Pads) for Equipment

Unless otherwise indicated, the slab must be at least 8 inches thick, reinforced with a 6 by 6 - W2.9 by W2.9 mesh, placed uniformly 4 inches from the top of the slab. Place slab on a 6 inch thick, well-compacted gravel base. Top of concrete slab must be approximately 4 inches above finished grade with gradual slope for drainage. Edges above grade must have 1/2 inch chamfer. Slab must be of adequate size to project at least 8 inches beyond the equipment.

Stub up conduits, with bushings, 2 inches into cable wells in the concrete pad. Coordinate dimensions of cable wells with transformer cable training areas.

### 3.18 FIELD QUALITY CONTROL

#### 3.18.1 Performance of Field 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.

##### 3.18.1.1 Medium Voltage Cables

Perform tests after installation of cable, splices, and terminators and before terminating to equipment or splicing to existing circuits.

##### a. Visual and Mechanical Inspection

- (1) Inspect exposed cable sections for physical damage.
- (2) Verify that cable is supplied and connected in accordance with contract plans and specifications.
- (3) Inspect for proper shield grounding, cable support, and cable termination.
- (4) Verify that cable bends are not less than ICEA or manufacturer's minimum allowable bending radius.
- (5) Inspect for proper fireproofing.
- (6) Visually inspect jacket and insulation condition.
- (7) Inspect for proper phase identification and arrangement.

##### b. Electrical Tests

- (1) Perform a shield continuity test on each power cable by ohmmeter method. Record ohmic value, resistance values in excess of 10 ohms per 1000 feet of cable must be investigated and justified.

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- (2) Perform acceptance test on new cables before the new cables are connected to existing cables and placed into service, including terminations and joints. Perform maintenance test on complete cable system after the new cables are connected to existing cables and placed into service, including existing cable, terminations, and joints. Tests must be very low frequency (VLF) alternating voltage withstand tests in accordance with IEEE 400.2. VLF test frequency must be 0.05 Hz minimum for a duration of 60 minutes using a sinusoidal waveform. Test voltages must be as follows:

| CABLE RATING AC TEST VOLTAGE<br>for ACCEPTANCE TESTING |                 |
|--------------------------------------------------------|-----------------|
| 5 kV                                                   | 10kV rms (peak) |
| 8 kV                                                   | 13kV rms (peak) |
| 15 kV                                                  | 20kV rms (peak) |
| 25 kV                                                  | 31kV rms (peak) |
| 35 kV                                                  | 44kV rms (peak) |

| CABLE RATING AC TEST VOLTAGE<br>for MAINTENANCE TESTING |                 |
|---------------------------------------------------------|-----------------|
| 5 kV                                                    | 7kV rms (peak)  |
| 8 kV                                                    | 10kV rms (peak) |
| 15 kV                                                   | 16kV rms (peak) |
| 25 kV                                                   | 23kV rms (peak) |
| 35 kV                                                   | 33kV rms (peak) |

#### 3.18.1.2 Low Voltage Cables, 600-Volt

Perform tests after installation of cable, splices and terminations and before terminating to equipment or splicing to existing circuits.

##### a. Visual and Mechanical Inspection

- (1) Inspect exposed cable sections for physical damage.
- (2) Verify that cable is supplied and connected in accordance with contract plans and specifications.
- (3) Verify tightness of accessible bolted electrical connections.
- (4) Inspect compression-applied connectors for correct cable match and indentation.
- (5) Visually inspect jacket and insulation condition.
- (6) Inspect for proper phase identification and arrangement.

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b. Electrical Tests

- (1) Perform insulation resistance tests on wiring No. 6 AWG and larger diameter using instrument which applies voltage of approximately 1000 volts dc for one minute.
- (2) Perform continuity tests to insure correct cable connection.

3.18.1.3 Grounding System

a. Visual and mechanical inspection

Inspect ground system for compliance with contract plans and specifications.

b. Electrical tests

Perform ground-impedance measurements utilizing the fall-of-potential method in accordance with IEEE 81. 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 resistance tester in accordance with manufacturer's instructions to test each ground or group of grounds. The instrument must 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. Provide site diagram indicating location of test probes with associated distances, and provide a plot of resistance vs. distance.

3.18.2 Follow-Up Verification

Upon completion of acceptance checks and tests, show by demonstration in service that circuits and devices are in good operating condition and properly performing the intended function. As an exception to requirements stated elsewhere in the contract, the Contracting Officer must be given 5 working days advance notice of the dates and times of checking and testing.

.... -- End of Section --