



Project Manual

Palmer Courthouse Renovation & Expansion
515 East Dahlia Avenue
Palmer, AK 99645

February 19, 2026

Prepared for:
Alaska Court System

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Stantec Project No. 2014331970

Volume 01: Divisions 00-33

DOCUMENT 00 01 07 - SEALS PAGES

1.1 ARCHITECTURE

- A. I hereby certify that the architectural portions of this Project Specification were prepared by me or under my direct supervision and that I am a duly registered Architect under the laws of the State of Alaska.



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1.2 CIVIL ENGINEERING

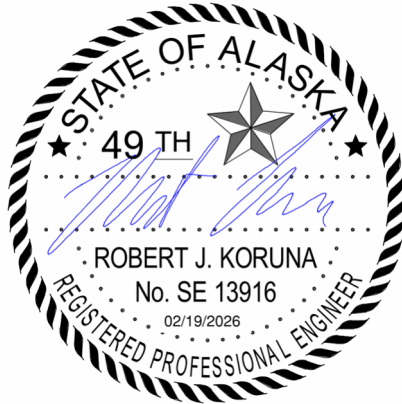
- A. I hereby certify that the civil portions of this Project Specification were prepared by me or under my direct supervision and that I am a duly registered Professional Engineer under the laws of the State of Alaska.



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1.3 STRUCTURAL ENGINEERING

- A. I hereby certify that the structural portions of this Project Specification were prepared by me or under my direct supervision and that I am a duly registered Professional Engineer under the laws of the State of Alaska.



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1.4 MECHANICAL ENGINEERING

- A. I hereby certify that the mechanical portions of this Project Specification were prepared by me or under my direct supervision and that I am a duly registered Professional Engineer under the laws of the State of Alaska.



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1.5 ELECTRICAL ENGINEERING

- A. I hereby certify that the electrical portions of this Project Specification were prepared by me or under my direct supervision and that I am a duly registered Professional Engineer under the laws of the State of Alaska.



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END OF DOCUMENT

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SECTION 01 45 33
CODE-REQUIRED SPECIAL INSPECTIONS AND PROCEDURES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Code-required special inspections.
- B. Testing services incidental to special inspections.
- C. Submittals.

1.02 DEFINITIONS

- A. Code or Building Code: ICC (IBC), International Building Code, most recent edition adopted by authority having jurisdiction, including all applicable amendments and supplements without limitation, and specifically Chapter 17 - Special Inspections and Tests.
- B. Authority Having Jurisdiction (AHJ): Agency or individual officially empowered to enforce the building, fire and life safety code requirements of the permitting jurisdiction in which the Project is located.
- C. Special Inspections and Tests: Inspections and testing of materials, installation, fabrication, erection, or placement of components and connections mandated by Building Code to safeguard public welfare.
 - 1. Special inspections and tests are separate from and independent of tests and inspections conducted by Owner or Contractor for purposes of quality assurance and contract administration.

1.03 REFERENCE STANDARDS

- A. ASTM E329 - Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection; 2025.
- B. IAS AC89 - Accreditation Criteria for Testing Laboratories; 2021.
- C. IAS AC291 - Accreditation Criteria for Special Inspection Agencies AC291; 2025.
- D. ICC (IBC) - International Building Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Special Inspection Agency Qualifications: Prior to start of work, Special Inspection Agency is required to:
 - 1. Submit agency name, address, and telephone number, names of full time registered Engineer and responsible officer.
 - 2. Submit certification that Special Inspection Agency is acceptable to AHJ.
- C. Testing Agency Qualifications: Prior to start of work, Testing Agency is required to:
 - 1. Submit agency name, address, and telephone number, and names of full time registered Engineer and responsible officer.
 - 2. Submit certification that Testing Agency is acceptable to AHJ.
- D. Fabricator's Qualification Statement: When required by AHJ, submit documentation of fabrication facilities and methods and quality control procedures. Include documentation of AHJ approval.
- E. Special Inspection Reports: After each special inspection, Special Inspector is required to submit at least two copies of report; one to Architect and one to AHJ.
 - 1. Include:
 - a. Date issued.
 - b. Project title and number.

- c. Name of Special Inspector.
 - d. Date and time of special inspection.
 - e. Identification of product and specifications section.
 - f. Location in the Project.
 - g. Type of special inspection.
 - h. Date of special inspection.
 - i. Results of special inspection.
 - j. Compliance with contract documents.
 - 2. Final Special Inspection Report: Document special inspections and correction of discrepancies prior to the start of the work.
- F. Fabricator Special Inspection Reports: After each special inspection of fabricated items at fabricator's facility, Special Inspector is required to submit report to Architect and to AHJ.
- 1. Include:
 - a. Date issued.
 - b. Project title and number.
 - c. Name of Special Inspector.
 - d. Date and time of special inspection.
 - e. Identification of fabricated item and specification section.
 - f. Location in the Project.
 - g. Results of special inspection.
 - h. Verification of fabrication and quality control procedures.
 - i. Compliance with contract documents.
 - j. Compliance with referenced standards.
- G. Test Reports: After each test or inspection, Testing Agency is required to submit report to Architect and to AHJ.
- 1. Include:
 - a. Date issued.
 - b. Project title and number.
 - c. Name of inspector.
 - d. Date and time of sampling or inspection.
 - e. Identification of product and specifications section.
 - f. Location in the Project.
 - g. Type of test or inspection.
 - h. Date of test or inspection.
 - i. Results of test or inspection.
 - j. Compliance with contract documents.
- H. Certificates: When required by AHJ, Special Inspector will submit certification by manufacturer, fabricator, and installation subcontractor to Architect and AHJ.
- 1. Indicate material or product complies with or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.

1.05 SPECIAL INSPECTION AND TESTING AGENCY

- A. Owner to employ services of Special Inspection Agency to perform Special Inspections as required by building code.
- B. Special Inspection Agency may delegate to independent testing agency to perform testing and sampling associated with special inspections and required by building code.
- C. Employment of agency in no way relieves Contractor of obligation to perform work in accordance with requirements of contract documents.

1.06 TESTING AND INSPECTION AGENCIES

- A. Owner to employ services of independent testing agency to perform testing and sampling required by the contract documents to support Special Inspections or associated with special inspections but not required by building code.
- B. Employment of agency in no way relieves Contractor of obligation to perform work in accordance with requirements of contract documents.

1.07 QUALITY ASSURANCE

- A. Special Inspection Agency Qualifications:
 - 1. Independent firm specializing in performing testing and inspections of the type specified in this section.
 - 2. Accredited by IAS according to IAS AC291.
- B. Testing Agency Qualifications:
 - 1. Independent firm specializing in performing testing and inspections of the type specified in this section.
 - 2. Accredited by IAS according to IAS AC89.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 SPECIAL INSPECTIONS AND TESTING

- A. The Code requires special inspections and testing of certain materials, components, assemblies, and connections used in constructing the project. Special inspections and testing will be performed in accordance with the Code.
- B. Special inspections and testing will be performed in accordance with the Code for the following materials and project components:
 - 1. Concrete.
 - 2. Masonry.
 - 3. Wood.
 - 4. Soils.
 - 5. Mastic and intumescent fire-resistant coatings.
 - 6. Fire-resistant penetrations and joints.
 - 7. Seismic resistance.
 - 8. Wind resistance.
 - 9. Structural observations required by ICC (IBC) section 1704.6.

3.02 SPECIAL INSPECTION AGENCY DUTIES AND RESPONSIBILITIES

- A. Special Inspection Agency shall:
 - 1. Verify samples submitted by Contractor comply with the referenced standards and the approved Contract Documents.
 - 2. Provide qualified personnel at site. Cooperate with Architect and Contractor in performance of services.
 - 3. Perform specified sampling and testing of products in accordance with specified reference standards.
 - 4. Ascertain compliance of materials and products with requirements of Contract Documents.
 - 5. Promptly notify Architect and Contractor of observed irregularities or non-compliance of work or products.
 - 6. Perform additional tests and inspections required by Architect.
 - 7. Submit reports of all tests or inspections specified.
- B. Limits on Special Inspection Agency Authority:
 - 1. Agency may not release, revoke, alter, or enlarge on requirements of Contract Documents.
 - 2. Agency may not approve or accept any portion of the work.

3. Agency may not assume any duties of Contractor.
4. Agency has no authority to stop the work.
- C. Re-testing required because of non-compliance with specified requirements shall be performed by the same agency on instructions by Architect.
- D. Re-testing required because of non-compliance with specified requirements shall be paid for by Contractor.

3.03 TESTING AGENCY DUTIES AND RESPONSIBILITIES

- A. Testing Agency Duties:
 1. Provide qualified personnel at site. Cooperate with Architect and Contractor in performance of services.
 2. Perform specified sampling and testing of products in accordance with specified standards.
 3. Ascertain compliance of materials and mixes with requirements of Contract Documents.
 4. Promptly notify Architect and Contractor of observed irregularities or non-compliance of work or products.
 5. Perform additional tests and inspections required by Architect.
 6. Submit reports of all tests or inspections specified.
- B. Limits on Testing or Inspection Agency Authority:
 1. Agency may not release, revoke, alter, or enlarge on requirements of Contract Documents.
 2. Agency may not approve or accept any portion of the work.
 3. Agency may not assume any duties of Contractor.
 4. Agency has no authority to stop the work.
- C. On instructions by Architect, perform re-testing required because of non-compliance with specified requirements, using the same agency.
- D. Contractor will pay for re-testing required because of non-compliance with specified requirements.

3.04 CONTRACTOR DUTIES AND RESPONSIBILITIES

- A. Contractor Responsibilities, General:
 1. Deliver to agency at designated location, adequate samples of materials for special inspections that require material verification.
 2. Cooperate with agency and laboratory personnel; provide access to approved documents at project site, to the work, to manufacturers' facilities, and to fabricators' facilities.
 3. Provide incidental labor and facilities:
 - a. To provide access to work to be tested or inspected.
 - b. To obtain and handle samples at the site or at source of Products to be tested or inspected.
 - c. To facilitate tests or inspections.
 - d. To provide storage and curing of test samples.
 4. Notify Architect and laboratory 24 hours prior to expected time for operations requiring testing or inspection services.
 5. Arrange with Owner's agency and pay for additional samples, tests, and inspections required by Contractor beyond specified requirements.

END OF SECTION

SECTION 01 57 13
TEMPORARY EROSION AND SEDIMENT CONTROL

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Prevention of erosion due to construction activities.
- B. Prevention of sedimentation of waterways, open drainage ways, and storm and sanitary sewers due to construction activities.
- C. Restoration of areas eroded due to insufficient preventive measures.
- D. Performance bond.
- E. Compensation of Owner for fines levied by authorities having jurisdiction due to non-compliance by Contractor.

1.02 REFERENCE STANDARDS

- A. ASTM D4355/D4355M - Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture, and Heat in a Xenon Arc-Type Apparatus; 2021.
- B. ASTM D4491/D4491M - Standard Test Methods for Water Permeability of Geotextiles by Permittivity; 2022.
- C. ASTM D4533/D4533M - Standard Test Method for Trapezoid Tearing Strength of Geotextiles; 2015 (Reapproved 2023).
- D. ASTM D4632/D4632M - Standard Test Method for Grab Breaking Load and Elongation of Geotextiles; 2015a (Reapproved 2023).
- E. ASTM D4751 - Standard Test Methods for Determining Apparent Opening Size of a Geotextile; 2021a.
- F. ASTM D4873/D4873M - Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples; 2017 (Reapproved 2021).

1.03 PERFORMANCE REQUIREMENTS

- A. Also comply with all more stringent requirements of State of Alaska Erosion and Sedimentation Control Manual.
- B. Comply with all requirements of State of Alaska or Palmer County for erosion and sedimentation control .
- C. Develop and follow an Erosion and Sedimentation Prevention Plan and submit periodic inspection reports.
- D. Do not begin clearing, grading, or other work involving disturbance of ground surface cover until applicable permits have been obtained; furnish all documentation required to obtain applicable permits.
 - 1. Owner will obtain permits and pay for securities required by authority having jurisdiction.
- E. Provide to Owner a Performance Bond covering erosion and sedimentation preventive measures only, in an amount equal to 100 percent of the cost of erosion and sedimentation control work.
- F. Timing: Put preventive measures in place as soon as possible after disturbance of surface cover and before precipitation occurs.
- G. Storm Water Runoff: Control increased storm water runoff due to disturbance of surface cover due to construction activities for this project.
 - 1. Prevent runoff into storm and sanitary sewer systems, including open drainage channels, in excess of actual capacity or amount allowed by authorities having jurisdiction, whichever is less.

2. Anticipate runoff volume due to the most extreme short term and 24-hour rainfall events that might occur in 25 years.
- H. Erosion On Site: Minimize wind, water, and vehicular erosion of soil on project site due to construction activities for this project.
 1. Control movement of sediment and soil from temporary stockpiles of soil.
 2. Prevent development of ruts due to equipment and vehicular traffic.
 3. If erosion occurs due to non-compliance with these requirements, restore eroded areas at no cost to Owner.
- I. Erosion Off Site: Prevent erosion of soil and deposition of sediment on other properties caused by water leaving the project site due to construction activities for this project.
 1. Prevent windblown soil from leaving the project site.
 2. Prevent tracking of mud onto public roads outside site.
 3. Prevent mud and sediment from flowing onto sidewalks and pavements.
 4. If erosion occurs due to non-compliance with these requirements, restore eroded areas at no cost to Owner.
- J. Sedimentation of Waterways On Site: Prevent sedimentation of waterways on the project site, including rivers, streams, lakes, ponds, open drainage ways, storm sewers, and sanitary sewers.
 1. If sedimentation occurs, install or correct preventive measures immediately at no cost to Owner; remove deposited sediments; comply with requirements of authorities having jurisdiction.
 2. If sediment basins are used as temporary preventive measures, pump dry and remove deposited sediment after each storm.
- K. Sedimentation of Waterways Off Site: Prevent sedimentation of waterways off the project site, including rivers, streams, lakes, ponds, open drainage ways, storm sewers, and sanitary sewers.
 1. If sedimentation occurs, install or correct preventive measures immediately at no cost to Owner; remove deposited sediments; comply with requirements of authorities having jurisdiction.
- L. Open Water: Prevent standing water that could become stagnant.
- M. Maintenance: Maintain temporary preventive measures until permanent measures have been established.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Erosion and Sedimentation Control Plan:
 1. Include:
 - a. Site plan identifying soils and vegetation, existing erosion problems, and areas vulnerable to erosion due to topography, soils, vegetation, or drainage.
 - b. Site plan showing grading; new improvements; temporary roads, traffic accesses, and other temporary construction; and proposed preventive measures.
 - c. Where extensive areas of soil will be disturbed, include storm water flow and volume calculations, soil loss predictions, and proposed preventive measures.
 - d. Schedule of temporary preventive measures, in relation to ground disturbing activities.
 - e. Other information required by law.
 - f. Format required by law is acceptable, provided any additional information specified is also included.
 2. Obtain the approval of the Plan by authorities having jurisdiction.
 3. Obtain the approval of the Plan by Owner.

- C. Certificate: Mill certificate for silt fence fabric attesting that fabric and factory seams comply with specified requirements, signed by legally authorized official of manufacturer; indicate actual minimum average roll values; identify fabric by roll identification numbers.
- D. Inspection Reports: Submit report of each inspection; identify each preventive measure, indicate condition, and specify maintenance or repair required and accomplished.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Grass Seed For Temporary Cover: Select a species appropriate to climate, planting season, and intended purpose. If same area will later be planted with permanent vegetation, do not use species known to be excessively competitive or prone to volunteer in subsequent seasons.
- B. Silt Fence Fabric: Polypropylene geotextile resistant to common soil chemicals, mildew, and insects; non-biodegradable; in longest lengths possible; fabric including seams with the following minimum average roll lengths:
 - 1. Average Opening Size: 30 U.S. Std. Sieve (0.600 mm), maximum, when tested in accordance with ASTM D4751.
 - 2. Permittivity: 0.05 sec^{-1} , minimum, when tested in accordance with ASTM D4491/D4491M.
 - 3. Ultraviolet Resistance: Retaining at least 70 percent of tensile strength, when tested in accordance with ASTM D4355/D4355M after 500 hours exposure.
 - 4. Tensile Strength: 100 pounds-force (450 N), minimum, in cross-machine direction; 124 pounds-force (550 N), minimum, in machine direction; when tested in accordance with ASTM D4632/D4632M.
 - 5. Elongation: 15 to 30 percent, when tested in accordance with ASTM D4632/D4632M.
 - 6. Tear Strength: 55 pounds-force (245 N), minimum, when tested in accordance with ASTM D4533/D4533M.
 - 7. Color: Manufacturer's standard, with embedment and fastener lines preprinted.
- C. Silt Fence Posts: One of the following, minimum 5 feet (1500 mm) long:
 - 1. Steel U- or T-section, with minimum mass of 1.33 pound per linear foot (1.98 kg per linear m).
 - 2. Softwood, 4 by 4 inches (100 by 100 mm) in cross section.
 - 3. Hardwood, 2 by 2 inches (50 by 50 mm) in cross section.
- D. Gravel: See Section 31 23 23 for aggregate.
- E. Concrete: See Section 03 30 00.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine site and identify existing features that contribute to erosion resistance; maintain such existing features to greatest extent possible.

3.02 PREPARATION

- A. Schedule work so that soil surfaces are left exposed for the minimum amount of time.

3.03 SCOPE OF PREVENTIVE MEASURES

- A. In all cases, if permanent erosion resistant measures have been installed temporary preventive measures are not required.
- B. Construction Entrances: Traffic-bearing aggregate surface.
 - 1. Width: As required; 20 feet (7 m), minimum.
 - 2. Length: 50 feet (16 m), minimum.
 - 3. Provide at each construction entrance from public right-of-way.

4. Where necessary to prevent tracking of mud onto right-of-way, provide wheel washing area out of direct traffic lane, with drain into sediment trap or basin.
- C. Linear Sediment Barriers: Made of silt fences.
 1. Provide linear sediment barriers:
 - a. Along downhill perimeter edge of disturbed areas, including soil stockpiles.
 - b. Across the entrances to culverts that receive runoff from disturbed areas.
 2. Space sediment barriers with the following maximum slope length upslope from barrier:
 - a. Slope of Less Than 2 Percent: 100 feet (30 m)..
 - b. Slope Between 2 and 5 Percent: 75 feet (23 m).
 - c. Slope Between 5 and 10 Percent: 50 feet (15 m).
 - d. Slope Between 10 and 20 Percent: 25 feet (7.5 m).
 - e. Slope Over 20 Percent: 15 feet (4.5 m).
- D. Storm Drain Curb Inlet Sediment Trap: Protect each curb inlet using one of the following measures:
 1. Filter fabric wrapped around hollow concrete blocks blocking entire inlet face area; use one piece of fabric wrapped at least 1-1/2 times around concrete blocks and secured to prevent dislodging; orient cores of blocks so runoff passes into inlet.
 2. Straw bale row blocking entire inlet face area; anchor into pavement.
- E. Storm Drain Drop Inlet Sediment Traps: As detailed on drawings.
- F. Temporary Splash Pads: Stone aggregate over filter fabric; size to suit application; provide at downspout outlets and storm water outlets.
- G. Soil Stockpiles: Protect using one of the following measures:
 1. Cover with polyethylene film, secured by placing soil on outer edges.
 2. Cover with mulch at least 4 inches (100 mm) thickness of pine needles, sawdust, bark, wood chips, or shredded leaves, or 6 inches (150 mm) of straw or hay.
- H. Mulching: Use only for areas that may be subjected to erosion for less than 6 months.
- I. Temporary Seeding: Use where temporary vegetated cover is required.

3.04 INSTALLATION

- A. Traffic-Bearing Aggregate Surface:
 1. Excavate minimum of 6 inches (150 mm).
 2. Place geotextile fabric full width and length, with minimum 12 inch (300 mm) overlap at joints.
 3. Place and compact at least 6 inches (150 mm) of 1 1/2 to 3 1/2 inch (40 to 90 mm) diameter stone.
- B. Silt Fences:
 1. Store and handle fabric in accordance with ASTM D4873/D4873M.
 2. Where slope gradient is less than 3:1 or barriers will be in place less than 6 months, use nominal 16 inch (405 mm) high barriers with minimum 36 inch (905 mm) long posts spaced at 6 feet (1830 mm) maximum, with fabric embedded at least 4 inches (100 mm) in ground.
 3. Where slope gradient is steeper than 3:1 or barriers will be in place over 6 months, use nominal 28 inch (710 mm) high barriers, minimum 48 inch (1220 mm) long posts spaced at 6 feet (1830 mm) maximum, with fabric embedded at least 6 inches (150 mm) in ground.
 4. Where slope gradient is steeper than 3:1 and vertical height of slope between barriers is more than 20 feet (6 m), use nominal 32 inch (810 mm) high barriers with woven wire reinforcement and steel posts spaced at 4 feet (1220 mm) maximum, with fabric embedded at least 6 inches (150 mm) in ground.
 5. Install with top of fabric at nominal height and embedment as specified.

6. Do not splice fabric width; minimize splices in fabric length; splice at post only, overlapping at least 18 inches (460 mm), with extra post.
 7. Fasten fabric to wood posts using one of the following:
 - a. Four nails per post with 3/4 inch (19 mm) diameter flat or button head, 1 inch (25 mm) long, and 14 gauge, 0.083 inch (2.11 mm) shank diameter.
 - b. Five staples per post with at least 17 gauge, 0.0453 inch (1.150 mm) wire, 3/4 inch (19 mm) crown width and 1/2 inch (12 mm) long legs.
 8. Fasten fabric to steel posts using wire, nylon cord, or integral pockets.
 9. Wherever runoff will flow around end of barrier or over the top, provide temporary splash pad or other outlet protection; at such outlets in the run of the barrier, make barrier not more than 12 inches (300 mm) high with post spacing not more than 4 feet (1220 mm).
- C. Temporary Seeding:
1. When hydraulic seeder is used, seedbed preparation is not required.
 2. When surface soil has been sealed by rainfall or consists of smooth undisturbed cut slopes, and conventional or manual seeding is to be used, prepare seedbed by scarifying sufficiently to allow seed to lodge and germinate.
 3. If temporary mulching was used on planting area but not removed, apply nitrogen fertilizer at 1 pound per 1000 sq ft (0.5 kg per 100 sq m).
 4. On soils of very low fertility, apply 10-10-10 fertilizer at rate of 12 to 16 pounds per 1000 sq ft (6 to 8 kg per 100 sq m).
 5. Incorporate fertilizer into soil before seeding.
 6. Apply seed uniformly; if using drill or cultipacker seeders place seed 1/2 to 1 inch (12 to 25 mm) deep.
 7. Irrigate as required to thoroughly wet soil to depth that will ensure germination, without causing runoff or erosion.
 8. Repeat irrigation as required until grass is established.

3.05 MAINTENANCE

- A. Inspect preventive measures weekly, within 24 hours after the end of any storm that produces 0.5 inches (13 mm) or more rainfall at the project site, and daily during prolonged rainfall.
- B. Repair deficiencies immediately.
- C. Silt Fences:
 1. Promptly replace fabric that deteriorates unless need for fence has passed.
 2. Remove silt deposits that exceed one-third of the height of the fence.
 3. Repair fences that are undercut by runoff or otherwise damaged, whether by runoff or other causes.
- D. Clean out temporary sediment control structures weekly and relocate soil on site.
- E. Place sediment in appropriate locations on site; do not remove from site.

3.06 CLEAN UP

- A. Remove temporary measures after permanent measures have been installed, unless permitted to remain by Architect.
- B. Clean out temporary sediment control structures that are to remain as permanent measures.
- C. Where removal of temporary measures would leave exposed soil, shape surface to an acceptable grade and finish to match adjacent ground surfaces.

END OF SECTION

SECTION 02 41 19 SELECTIVE DEMOLITION

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Demolition and removal of selected portions of building or structure.
 - 2. Demolition and removal of selected site elements.

1.02 REFERENCE STANDARDS

- A. American National Standards Institute (ANSI) A10.6: Safety Requirements for Demolition Operations.
- B. National Fire Protection Agency (NFPA) 241: Standard for Safeguarding Construction, Alteration, and Demolition Operations.
- C. Resilient Floor Covering Institute (RFCI): Recommended Work Practices for Removal of Resilient Floor Coverings.

1.03 DEFINITIONS

- A. Remove: Detach items from existing construction and dispose of them off-site unless indicated to be salvaged or reinstalled.
- B. Existing to Remain: Leave existing items that are not to be removed and that are not otherwise indicated to be salvaged or reinstalled.

1.04 MATERIALS OWNERSHIP

- A. Unless otherwise indicated, demolition waste becomes property of Contractor.

1.05 PREINSTALLATION MEETINGS

- A. Predemolition Conference: Conduct conference at Project site.
 - 1. Inspect and discuss condition of construction to be selectively demolished.
 - 2. Review structural load limitations of existing structure.
 - 3. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
 - 4. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
 - 5. Review areas where existing construction is to remain and requires protection.

1.06 INFORMATIONAL SUBMITTALS

- A. Proposed Protection Measures: Submit report, including Drawings, that indicates the measures proposed for protecting individuals and property for environmental protection, for dust control and, for noise control. Indicate proposed locations and construction of barriers.
- B. Schedule of Selective Demolition Activities: Indicate the following:
 - 1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure Owner's on-site operations are uninterrupted.
 - 2. Interruption of utility services. Indicate how long utility services will be interrupted.
 - 3. Coordination for shutoff, capping, and continuation of utility services.
 - 4. Use of elevator and stairs.
 - 5. Coordination of Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed Work.
- C. Predemolition Photographs or Video: Show existing conditions of adjoining construction, including finish surfaces, that might be misconstrued as damage caused by demolition operations. Submit before Work begins.

1.07 QUALITY ASSURANCE

- A. Demolition Firm Qualifications: An experienced firm that has specialized in demolition work similar in material and extent to that indicated for this Project.
- B. Pre-Demolition Conference: Conduct conference at Project site to review methods and procedures related to selective demolition including, but not limited to, the following:
 - 1. Inspect and discuss condition of construction to be selectively demolished.
 - 2. Review structural load limitations of existing structure.
 - 3. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
 - 4. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
 - 5. Review areas where existing construction is to remain and requires protection.

1.08 FIELD CONDITIONS

- A. Owner will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted.
- B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.
- C. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.
- D. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
 - 1. If suspected hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Hazardous materials will be removed by Owner.
- E. Utility Service:
 - 1. Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
 - 2. Maintain fire-protection facilities in service during selective demolition operations.

1.09 WARRANTY

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

1.10 COORDINATION

- A. Arrange selective demolition schedule so as not to interfere with Owner's operations.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
- B. Standards: Comply with ANSI/ASSP A10.6 and NFPA 241.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that utilities have been disconnected and capped before starting selective demolition operations.
- B. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.

- C. When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to Architect.
- D. Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities.

3.02 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

- A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.
- B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off utility services and mechanical/electrical systems serving areas to be selectively demolished.
 - 1. Owner will arrange to shut off indicated services/systems when requested by Contractor.
 - 2. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
 - 3. Disconnect, demolish, and remove fire-suppression systems, plumbing, and HVAC systems, equipment, and components indicated on Drawings to be removed.
 - a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
 - b. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material and leave in place.
 - c. Equipment to Be Removed: Disconnect and cap services and remove equipment.
 - d. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
 - e. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
 - f. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material and leave in place.

3.03 PROTECTION

- A. Temporary Protection: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
 - 1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
 - 2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.
 - 3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
 - 4. Cover and protect furniture, furnishings, and equipment that have not been removed.
 - 5. Comply with requirements for temporary enclosures, dust control, heating, and cooling specified in Section 01 56 00 "Temporary Barriers and Enclosures."
- B. Remove temporary barricades and protections where hazards no longer exist.

3.04 SELECTIVE DEMOLITION, GENERAL

- A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:
 - 1. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction.

- Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain.
2. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
 3. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations.
 4. Maintain adequate ventilation when using cutting torches.
 5. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
 6. Dispose of demolished items and materials promptly.
- B. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
- C. Removed and Reinstalled Items:
1. Clean and repair items to functional condition adequate for intended reuse.
 2. Pack or crate items after cleaning and repairing. Identify contents of containers.
 3. Protect items from damage during transport and storage.
 4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.
- D. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition.

3.05 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

- A. Concrete: Demolish in sections. Cut concrete full depth at junctures with construction to remain and at regular intervals using power-driven saw, and then remove concrete between saw cuts.
- B. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, and then remove masonry between saw cuts.
- C. Resilient Floor Coverings: Remove floor coverings and adhesive according to recommendations in RFCI's "Recommended Work Practices for the Removal of Resilient Floor Coverings."
- D. Roofing: Remove no more existing roofing than what can be covered in one day by new roofing and so that building interior remains watertight and weathertight. See Section 07 54 00 - Thermoplastic Membrane Roofing for new roofing requirements.

3.06 DISPOSAL OF DEMOLISHED MATERIALS

- A. Remove demolition waste materials from Project site and dispose of them in an EPA-approved construction and demolition waste landfill acceptable to authorities having jurisdiction and recycle or dispose of them as required.
1. Do not allow demolished materials to accumulate on-site.
 2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
 3. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
- B. Burning: Do not burn demolished materials.

3.07 CLEANING

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

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2/19/2026

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Palmer Courthouse Renovation & Expansion
100% Construction Documents

END OF SECTION

**SECTION 03 30 00
CAST-IN-PLACE CONCRETE**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Concrete formwork.
- B. Floors and slabs on grade.
- C. Concrete shear walls, elevator shaft walls, and foundation walls.
- D. Concrete reinforcement.
- E. Joint devices associated with concrete work.
- F. Miscellaneous concrete elements, including equipment pads, equipment pits, light pole bases, flagpole bases, thrust blocks, and manholes.
- G. Concrete curing.

1.02 RELATED REQUIREMENTS

- A. Section 07 92 00 - Joint Sealants: Products and installation for sealants and joint fillers for saw cut joints and isolation joints in slabs.

1.03 REFERENCE STANDARDS

- A. ACI CODE-318 - Building Code Requirements for Structural Concrete and Commentary; 2019 (Reapproved 2022).
- B. ACI PRC-211.1 - Selecting Proportions for Normal-Density and High Density-Concrete - Guide; 2022.
- C. ACI PRC-302.1 - Guide to Concrete Floor and Slab Construction; 2015.
- D. ACI PRC-304 - Guide for Measuring, Mixing, Transporting, and Placing Concrete; 2000 (Reapproved 2009).
- E. ACI PRC-306 - Guide to Cold Weather Concreting; 2016.
- F. ACI PRC-308 - Guide to External Curing of Concrete; 2016.
- G. ACI PRC-347 - Guide to Formwork for Concrete; 2014 (Reapproved 2021).
- H. ACI SPEC-117 - Specification for Tolerances for Concrete Construction and Materials; 2010 (Reapproved 2015).
- I. ACI SPEC-301 - Specifications for Concrete Construction; 2020.
- J. ASTM A615/A615M - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement; 2024.
- K. ASTM A1064/A1064M - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete; 2024.
- L. ASTM C33/C33M - Standard Specification for Concrete Aggregates; 2024a.
- M. ASTM C39/C39M - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens; 2024.
- N. ASTM C109/C109M - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 50 mm [2 in.] Cube Specimens); 2024.
- O. ASTM C143/C143M - Standard Test Method for Slump of Hydraulic-Cement Concrete; 2020.
- P. ASTM C150/C150M - Standard Specification for Portland Cement; 2024.
- Q. ASTM C173/C173M - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method; 2024a.
- R. ASTM C260/C260M - Standard Specification for Air-Entraining Admixtures for Concrete; 2024.

- S. ASTM C494/C494M - Standard Specification for Chemical Admixtures for Concrete; 2024.
- T. ASTM C685/C685M - Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing; 2024.
- U. ASTM C827/C827M - Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures; 2023.
- V. ASTM C881/C881M - Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete; 2020a.
- W. ASTM C1107/C1107M - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink); 2020.
- X. ASTM C1602/C1602M - Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete; 2022.
- Y. ASTM D8139 - Standard Specification for Semi-Rigid, Closed-Cell Polypropylene Foam, Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction; 2023.
- Z. ASTM E1643 - Standard Practice for Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs; 2024.
- AA. ASTM E1745 - Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs; 2017 (Reapproved 2023).

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Submit manufacturers' data on manufactured products showing compliance with specified requirements and installation instructions.
 - 1. For curing compounds, provide data on method of removal in the event of incompatibility with floor covering adhesives.
- C. Mix Design: Submit proposed concrete mix design.
 - 1. Indicate proposed mix design complies with requirements of ACI SPEC-301, Section 4 - Concrete Mixtures.
 - 2. Indicate proposed mix design complies with requirements of ACI CODE-318, Chapter 5 - Concrete Quality, Mixing and Placing.
- D. Samples: Submit samples of underslab vapor retarder to be used.
- E. Test Reports: Submit report for each test or series of tests specified.

1.05 QUALITY ASSURANCE

- A. Perform work of this section in accordance with ACI SPEC-301 and ACI CODE-318.
- B. Follow recommendations of ACI PRC-306 when concreting during cold weather.

PART 2 PRODUCTS

2.01 FORMWORK

- A. Formwork Design and Construction: Comply with guidelines of ACI PRC-347 to provide formwork that will produce concrete complying with tolerances of ACI SPEC-117.
- B. Form Materials: Contractor's choice of standard products with sufficient strength to withstand hydrostatic head without distortion in excess of permitted tolerances.
 - 1. Form Facing for Exposed Finish Concrete: Contractor's choice of materials that will provide smooth, stain-free final appearance.
 - 2. Earth Cuts: Do not use earth cuts as forms for vertical surfaces. Natural rock formations that maintain a stable vertical edge may be used as side forms.
 - 3. Form Coating: Release agent that will not adversely affect concrete or interfere with application of coatings.

4. Form Ties: Cone snap type that will leave no metal within 1-1/2 inches (38 mm) of concrete surface.

2.02 REINFORCEMENT MATERIALS

- A. Reinforcing Steel: ASTM A615/A615M, Grade 60 (60,000 psi) (420 MPa).
 1. Type: Deformed billet-steel bars.
 2. Finish: Unfinished, unless otherwise indicated.
- B. Steel Welded Wire Reinforcement (WWR): Galvanized, plain type, ASTM A1064/A1064M.
 1. Form: Coiled Rolls.
 2. WWR Style: As indicated on drawings.
- C. Reinforcement Accessories:
 1. Tie Wire: Annealed, minimum 16 gauge, 0.0508 inch (1.29 mm).
 2. Chairs, Bolsters, Bar Supports, Spacers: Sized and shaped for adequate support of reinforcement during concrete placement.

2.03 CONCRETE MATERIALS

- A. Cement: ASTM C150/C150M, Type I or III Portland type.
 1. Acquire cement for entire project from same source.
- B. Fine and Coarse Aggregates: ASTM C33/C33M.
 1. Acquire aggregates for entire project from same source.
- C. Water: ASTM C1602/C1602M; clean, potable, and not detrimental to concrete.

2.04 ADMIXTURES

- A. Do not use chemicals that will result in soluble chloride ions in excess of 0.1 percent by weight of cement.
- B. Air Entrainment Admixture: ASTM C260/C260M.
- C. High Range Water Reducing Admixture: ASTM C494/C494M Type F.
- D. Water Reducing Admixture: ASTM C494/C494M Type A.

2.05 ACCESSORY MATERIALS

- A. Underslab Vapor Retarder:
 1. Sheet Material: ASTM E1745, Class A; 10-mil minimum. stated by manufacturer as suitable for installation in contact with soil or granular fill under concrete slabs. Single-ply polyethylene is prohibited.
 2. Accessory Products: Vapor retarder manufacturer's recommended tape, adhesive, mastic, prefabricated boots, etc., for sealing seams and penetrations.
- B. Non-Shrink Cementitious Grout: Premixed compound consisting of nonmetallic aggregate, cement, water reducing and plasticizing agents.
 1. Grout: Comply with ASTM C1107/C1107M.
 2. Height Change, Plastic State; when tested in accordance with ASTM C827/C827M:
 - a. Maximum: Plus 4 percent.
 - b. Minimum: Plus 1 percent.
 3. Minimum Compressive Strength at 48 Hours, ASTM C109/C109M: 2,000 pounds per square inch (13.7 MPa).
 4. Minimum Compressive Strength at 28 Days, ASTM C109/C109M: 7,000 pounds per square inch (48 MPa).

2.06 BONDING AND JOINTING PRODUCTS

- A. Epoxy Bonding System:
 1. Complying with ASTM C881/C881M and of Type required for specific application.

- B. Slab Isolation Joint Filler: 1/2-inch (13 mm) thick, height equal to slab thickness, with removable top section forming 1/2-inch (13 mm) deep sealant pocket after removal.
 - 1. Material: ASTM D8139, semi-rigid, closed-cell polypropylene foam.
- C. Slab Construction Joint Devices: Combination keyed joint form and screed, galvanized steel, with rectangular or round knockout holes for conduit or rebar to pass through joint form at 6 inches (150 mm) on center; ribbed steel stakes for setting.

2.07 CURING MATERIALS

- A. Curing Compound, Naturally Dissipating: Clear, water-based, liquid membrane-forming compound; complying with ASTM C309.

2.08 CONCRETE MIX DESIGN

- A. Proportioning Normal Weight Concrete: Comply with ACI PRC-211.1 recommendations.
- B. Concrete Strength: Establish required average strength for each type of concrete on the basis of field experience, as specified in ACI SPEC-301.
- C. Admixtures: Add acceptable admixtures as recommended in ACI PRC-211.1 and at rates recommended or required by manufacturer.
- D. Normal Weight Concrete:
 - 1. Compressive Strength, when tested in accordance with ASTM C39/C39M at 28 days: As indicated on drawings.
 - 2. Water-Cement Ratio: Maximum 45 percent by weight.
 - 3. Total Air Content: 6 percent +/- 1.5 percent for exterior concrete, maximum of 1.5 percent for interior slab,, determined in accordance with ASTM C173/C173M.
 - 4. Maximum Aggregate Size: 3/4 inch (19 mm).

2.09 MIXING

- A. On Project Site: Mix in drum type batch mixer, complying with ASTM C685/C685M. Mix each batch not less than 1-1/2 minutes and not more than 5 minutes.
- B. Adding Water: If concrete arrives on-site with slump less than suitable for placement, do not add water that exceeds the maximum water-cement ratio or exceeds the maximum permissible slump.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify lines, levels, and dimensions before proceeding with work of this section.

3.02 PREPARATION

- A. Formwork: Comply with requirements of ACI SPEC-301. Design and fabricate forms to support all applied loads until concrete is cured and for easy removal without damage to concrete.
- B. Verify that forms are clean and free of rust before applying release agent.
- C. Coordinate placement of embedded items with erection of concrete formwork and placement of form accessories.
- D. Where new concrete is to be bonded to previously placed concrete, prepare existing surface by cleaning and applying bonding agent in according to bonding agent manufacturer's instructions.
 - 1. Use epoxy bonding system for bonding to damp surfaces, for structural load-bearing applications, and where curing under humid conditions is required.
- E. Interior Slabs on Grade: Install vapor retarder under interior slabs on grade. Comply with ASTM E1643. Lap joints minimum 6 inches (150 mm). Seal joints, seams and penetrations watertight with manufacturer's recommended products and follow manufacturer's written instructions. Repair damaged vapor retarder before covering.

3.03 INSTALLING REINFORCEMENT AND OTHER EMBEDDED ITEMS

- A. Comply with requirements of ACI SPEC-301. Clean reinforcement of loose rust and mill scale, and accurately position, support, and secure in place to achieve not less than minimum concrete coverage required for protection.
- B. Install welded wire reinforcement in maximum possible lengths, and offset end laps in both directions. Splice laps with tie wire.

3.04 PLACING CONCRETE

- A. Place concrete in accordance with ACI PRC-304.
- B. Place concrete for floor slabs in accordance with ACI PRC-302.1.
- C. Notify Architect not less than 24 hours prior to commencement of placement operations.
- D. Maintain records of concrete placement. Record date, location, quantity, air temperature, and test samples taken.
- E. Ensure reinforcement, inserts, waterstops, embedded parts, and formed construction joint devices will not be disturbed during concrete placement.
- F. Place concrete continuously without construction (cold) joints wherever possible; where construction joints are necessary, before next placement prepare joint surface by removing laitance and exposing the sand and sound surface mortar, by sandblasting or high-pressure water jetting.
- G. Finish floors level and flat, unless otherwise indicated, within the tolerances specified below.

3.05 SLAB JOINTING

- A. Locate joints as indicated on drawings.
- B. Anchor joint fillers and devices to prevent movement during concrete placement.
- C. Isolation Joints: Use preformed joint filler with removable top section for joint sealant, total height equal to thickness of slab, set flush with top of slab.
- D. Saw Cut Contraction Joints: Saw cut joints before concrete begins to cool, within 4 to 12 hours after placing; use 3/16 inch (5 mm) thick blade and cut at least 1 inch (25 mm) deep but not less than one quarter (1/4) the depth of the slab.
- E. Construction Joints: Where not otherwise indicated, use metal combination screed and key form, with removable top section for joint sealant.

3.06 FLOOR FLATNESS AND LEVELNESS TOLERANCES

- A. Contractor to use an independent testing agency to inspect finished slabs for compliance with specified tolerances.
- B. Maximum Variation of Surface Flatness:
 - 1. Exposed Concrete Floors: 1/4 inch (6 mm) in 10 feet (3 m).
 - 2. Under Seamless Resilient Flooring: 1/4 inch (6 mm) in 10 feet (3 m).
 - 3. Under Carpeting: 1/4 inch (6 mm) in 10 feet (3 m).
- C. Correct the slab surface if tolerances are less than specified.
- D. Correct defects by grinding or by removal and replacement of the defective work. Areas requiring corrective work will be identified. Re-measure corrected areas by the same process.

3.07 CONCRETE FINISHING

- A. Unexposed Form Finish: Rub down or chip off fins or other raised areas 1/4 inch (6 mm) or more in height.
- B. Exposed Form Finish: Rub down or chip off and smooth fins or other raised areas 1/4 inch (6 mm) or more in height. Provide finish as follows:
 - 1. Smooth Rubbed Finish: Wet concrete and rub with carborundum brick or other abrasive, not more than 24 hours after form removal.

- C. Concrete Slabs: Finish to requirements of ACI PRC-302.1 and as follows:
 - 1. Surfaces to Receive Thin Floor Coverings: "Steel trowel" as described in ACI PRC-302.1; thin floor coverings include carpeting, resilient flooring, seamless flooring, resinous matrix terrazzo, thin set quarry tile, and thin set ceramic tile.
 - 2. Other Surfaces to Be Left Exposed: Trowel as described in ACI PRC-302.1, minimizing burnish marks and other appearance defects.
- D. In areas with floor drains, maintain floor elevation at walls; pitch surfaces uniformly to drains at 1:100 nominal.

3.08 CURING AND PROTECTION

- A. Comply with requirements of ACI PRC-308. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.
- B. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.
 - 1. Normal concrete: Not less than seven days.
- C. Surfaces Not in Contact with Forms:
 - 1. Slabs and Floors To Receive Adhesive-Applied Flooring: Curing compounds and other surface coatings are usually considered unacceptable by flooring and adhesive manufacturers. If such materials must be used, either obtain the approval of the flooring and adhesive manufacturers prior to use or remove the surface coating after curing to flooring manufacturer's satisfaction.
 - 2. Initial Curing: Start as soon as free water has disappeared and before surface is dry. Keep continuously moist for not less than three days by water ponding, water-saturated sand, water-fog spray, or saturated burlap.
 - 3. Final Curing: Begin after initial curing but before surface is dry.

3.09 FIELD QUALITY CONTROL

- A. An independent testing agency will perform field quality control tests, as specified in Section 01 40 00 - Quality Requirements.
- B. Provide free access to concrete operations at project site and cooperate with appointed firm.
- C. Tests of concrete and concrete materials may be performed at any time to ensure compliance with specified requirements.
- D. Compressive Strength Tests: ASTM C39/C39M, for each test, mold and cure three concrete test cylinders. Obtain test samples for every 75 cubic yards (57 cu m) or less of each class of concrete placed and for each separate non-concurrent placement.
- E. Take one additional test cylinder during cold weather concreting, cured on job site under same conditions as concrete it represents.
- F. Perform one slump test for each set of test cylinders taken, following procedures of ASTM C143/C143M.

3.10 DEFECTIVE CONCRETE

- A. Test Results: The testing agency shall report test results in writing to Architect and Contractor within 24 hours of test.
- B. Defective Concrete: Concrete not complying with required lines, details, dimensions, tolerances or specified requirements.
- C. Repair or replacement of defective concrete will be determined by the Architect. The cost of additional testing shall be borne by Contractor when defective concrete is identified.
- D. Do not patch, fill, touch-up, repair, or replace exposed concrete except upon express direction of Architect for each individual area.

3.11 PROTECTION

- A. Do not permit traffic over unprotected concrete floor surface until fully cured.

END OF SECTION

**SECTION 04 26 13
MASONRY VENEER**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Concrete block.
- B. Mortar.
- C. Reinforcement and anchorage.
- D. Flashings.
- E. Accessories.

1.02 RELATED REQUIREMENTS

- A. Section 07 62 00 - Sheet Metal Flashing and Trim: Through-wall masonry flashings.
- B. Section 07 92 00 - Joint Sealants: Sealing control and expansion joints.

1.03 REFERENCE STANDARDS

- A. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.
- B. ASTM A951/A951M - Standard Specification for Steel Wire for Masonry Joint Reinforcement; 2022.
- C. ASTM C91/C91M - Standard Specification for Masonry Cement; 2025.
- D. ASTM C129 - Standard Specification for Dry-Cast Nonloadbearing Concrete Masonry Units; 2025.
- E. ASTM C270 - Standard Specification for Mortar for Unit Masonry; 2025a.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data for masonry units, fabricated wire reinforcement, and mortar.
- C. Samples: Submit four samples of decorative block units to illustrate color, texture, and extremes of color range.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of experience.

1.06 MOCK-UP

- A. Construct a masonry wall as a mock-up panel sized 8 feet (2.4 m) long by 6 feet (1.8 m) high; include mortar and accessories and structural backup in mock-up.
- B. Locate where directed.
- C. Mock-up may remain as part of the Work.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, handle, and store masonry units by means that will prevent mechanical damage and contamination by other materials.

1.08 FIELD CONDITIONS

- A. Cold and Hot Weather Requirements: Comply with requirements of TMS 402/602 or applicable building code, whichever is more stringent.

PART 2 PRODUCTS

2.01 CONCRETE MASONRY UNITS

- A. Concrete Block: Comply with referenced standards and as follows:
 - 1. Size: Standard units with nominal face dimensions of 16 by 8 inches (400 by 200 mm) and nominal depths as indicated on drawings for specific locations.
 - 2. Non-Loadbearing Units: ASTM C129.
 - a. Style: Splitfaced.
 - b. Color: As selected by architect from manufacturer's standard options.
 - c. Provide with integral water repelling admixture. Use Master Builders MasterPel or equivalent.

2.02 MORTAR MATERIALS

- A. Masonry Cement: ASTM C91/C91M Type N.
 - 1. Colored Mortar: Premixed cement as required to match Architect's color sample.
- B. Water: Clean and potable.

2.03 REINFORCEMENT AND ANCHORAGE

- A. Joint Reinforcement Standard: ASTM A951/A951M.
- B. Masonry Veneer Anchors: 2-piece anchors that permit differential movement between masonry veneer and structural backup, hot dip galvanized to ASTM A 153/A 153M, Class B.
 - 1. Anchor plates: Not less than 0.075 inch (1.91 mm) thick, designed for fastening to structural backup through sheathing by two fasteners; provide design with legs that penetrate sheathing and insulation to provide positive anchorage.
 - 2. Wire ties: Manufacturer's standard shape, 0.1875 inch (4.75 mm) thick.
 - 3. Vertical adjustment: Not less than 3-1/2 inches (89 mm).
 - 4. Seismic Feature: Provide lip, hook, or clip on end of wire ties to engage or enclose not less than one continuous horizontal joint reinforcement wire of 0.1483 inch (3.8 mm) diameter.
 - 5. Manufacturers:
 - a. Hohmann & Barnard, Inc; _____: www.h-b.com/#sle.

2.04 FLASHINGS

- A. Metal Flashing Materials: Galvanized metal, as specified in Section 07 62 00.

2.05 ACCESSORIES

- A. Weeps:
 - 1. Type: Preformed aluminum vents with sloping louvers.
 - 2. Color(s): As selected by Architect from manufacturer's full range.
- B. Cavity Vents:
 - 1. Type: Polyester mesh.
 - 2. Manufacturers:
 - a. Basis of Design: Provide Mortar Net Solutions; WeepVent: www.mortarnet.com/#sle or an equal product by one of the following:
 - b. CavClear, a Division of Archovations Inc: www.cavclear.com/#sle.
 - c. Hohmann & Barnard, Inc: www.h-b.com/#sle.
 - d. WIRE-BOND: www.wirebond.com/#sle.
- C. Cleaning Solution: Non-acidic, not harmful to masonry work or adjacent materials.

2.06 MORTAR MIXING

- A. Mortar for Unit Masonry: ASTM C270, Proportion Specification.
 - 1. Exterior, non-loadbearing masonry; Type N.

PART 3 EXECUTION

3.01 COURSING

- A. Establish lines, levels, and coursing indicated. Protect from displacement.

- B. Maintain masonry courses to uniform dimension. Form vertical and horizontal joints of uniform thickness.
- C. Concrete Masonry Units:
 - 1. Bond: As indicated on drawings..

3.02 PLACING AND BONDING

- A. Lay solid masonry units in full bed of mortar, with full head joints, uniformly jointed with other work.
- B. Remove excess mortar as work progresses.
- C. Perform job site cutting of masonry units with proper tools to provide straight, clean, unchipped edges. Prevent broken masonry unit corners or edges.

3.03 WEEPS/CAVITY VENTS

- A. Install weeps in veneer walls at 24 inches (600 mm) on center horizontally on top of through-wall flashing above shelf angles and lintels and at bottom of walls.
- B. Install cavity vents in veneer walls at 32 inches (800 mm) on center horizontally below shelf angles and lintels and at top of walls.

3.04 REINFORCEMENT AND ANCHORAGE - MASONRY VENEER

- A. Install horizontal joint reinforcement 16 inches (400 mm) on center.
- B. Place masonry joint reinforcement in first and second horizontal joints above and below openings. Extend minimum 16 inches (400 mm) each side of opening.
- C. Place continuous joint reinforcement in first and second joint below top of walls.
- D. Embed longitudinal wires of joint reinforcement in mortar joint with at least 5/8 inch (16 mm) mortar cover on each side.
- E. Lap joint reinforcement ends minimum 6 inches (150 mm).
- F. Stud Back-Up: Secure veneer anchors to stud framed back-up and embed into masonry veneer at maximum 16 inches (400 mm) on center vertically and 16 inches (400 mm) on center horizontally. Place additional anchors at perimeter of openings and ends of panels, so maximum spacing of anchors is 8 inches (200 mm) on center.
- G. Seismic Reinforcement: Connect veneer anchors with continuous horizontal wire reinforcement before embedding anchors in mortar.

3.05 MASONRY FLASHINGS

- A. Whether or not specifically indicated, install masonry flashing to divert water to exterior at all locations where downward flow of water will be interrupted.

3.06 CLEANING

- A. Clean soiled surfaces with cleaning solution.

3.07 PROTECTION

- A. Without damaging completed work, provide protective boards at exposed external corners that are subject to damage by construction activities.
- B. Coat finished CMU venner with clear Sioxane penetrating sealer. Use DRYLOCK Sioxane 7 Brick and Masonry Penetrating Sealer or eq

END OF SECTION

**SECTION 05 50 00
METAL FABRICATIONS**

PART 1 GENERAL

1.01 REFERENCE STANDARDS

- A. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.
- B. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2024.
- C. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2024.
- D. ASTM A283/A283M - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates; 2024.
- E. ASTM A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength; 2021.
- F. ASTM A501/A501M - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing; 2021.
- G. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength; 2023.
- H. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination; 2020.
- I. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2025.
- J. SSPC-Paint 15 - Steel Joist Shop Primer/Metal Building Primer; 2004.
- K. SSPC-Paint 20 - Zinc-Rich Coating (Type I - Inorganic, and Type II - Organic); 2019.
- L. SSPC-SP 2 - Hand Tool Cleaning; 2024.

1.02 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories. Include erection drawings, elevations, and details where applicable.
 - 1. Indicate welded connections using standard AWS A2.4 welding symbols. Indicate net weld lengths.

PART 2 PRODUCTS

2.01 MATERIALS - STEEL

- A. Steel Sections: ASTM A36/A36M.
- B. Steel Tubing: ASTM A501/A501M hot-formed structural tubing.
- C. Plates: ASTM A283/A283M.
- D. Pipe: ASTM A53/A53M, Grade B Schedule 40, black finish.
- E. Slotted Channel Fittings: ASTM A1011/A1011M.
- F. Mechanical Fasteners: Same material as or compatible with materials being fastened; type consistent with design and specified quality level.
- G. Bolts, Nuts, and Washers: ASTM A307, Grade A, plain.
- H. Welding Materials: AWS D1.1/D1.1M; type required for materials being welded.
- I. Shop and Touch-Up Primer: SSPC-Paint 15, complying with VOC limitations of authorities having jurisdiction.

- J. Touch-Up Primer for Galvanized Surfaces: SSPC-Paint 20, Type I - Inorganic, complying with VOC limitations of authorities having jurisdiction.

2.02 FABRICATION

- A. Fit and shop assemble items in largest practical sections, for delivery to site.
- B. Fabricate items with joints tightly fitted and secured.
- C. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.
- D. Furnish components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.

2.03 FINISHES - STEEL

- A. Prime paint steel items.
 - 1. Exceptions: Galvanize items to be embedded in concrete and exterior items, and items noted to be galvanized or hdg..
- B. Prepare surfaces to be primed in accordance with SSPC-SP2.
- C. Clean surfaces of rust, scale, grease, and foreign matter prior to finishing.
- D. Prime Painting: One coat.
- E. Galvanizing: Galvanize after fabrication to ASTM A123/A123M requirements. Provide minimum 1.7 oz/sq ft galvanized coating. (Provide minimum 530 g/sq m galvanized coating.)

2.04 FABRICATION TOLERANCES

- A. Squareness: 1/8 inch (3 mm) maximum difference in diagonal measurements.
- B. Maximum Offset Between Faces: 1/16 inch (1.5 mm).
- C. Maximum Misalignment of Adjacent Members: 1/16 inch (1.5 mm).
- D. Maximum Bow: 1/8 inch (3 mm) in 48 inches (1.2 m).
- E. Maximum Deviation From Plane: 1/16 inch (1.5 mm) in 48 inches (1.2 m).

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field conditions are acceptable and are ready to receive work.

3.02 INSTALLATION

- A. Install items plumb and level, accurately fitted, free from distortion or defects.
- B. Provide for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.
- C. Obtain approval prior to site cutting or making adjustments not scheduled.

END OF SECTION

**SECTION 05 52 13
PIPE AND TUBE RAILINGS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Railings and guardrails as detailed on the Drawings.

1.02 RELATED REQUIREMENTS

- A. Section 09 91 13 - Exterior Painting: Paint finish.
- B. Section 09 91 23 - Interior Painting: Paint finish.

1.03 REFERENCE STANDARDS

- A. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.
- B. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2024.
- C. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2024.
- D. ASTM A500/A500M - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes; 2023.
- E. ASTM E935 - Standard Test Methods for Performance of Permanent Metal Railing Systems and Rails for Buildings; 2021.
- F. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2025.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate profiles, sizes, connection attachments, anchorage, size and type of fasteners, and accessories.

1.05 QUALITY ASSURANCE

- A. Fabricator Qualifications:
 - 1. A company specializing in manufacturing products specified in this section, with not less than ten years of documented experience.

PART 2 PRODUCTS

2.01 RAILINGS - GENERAL REQUIREMENTS

- A. Design, fabricate, and test railing assemblies in accordance with the most stringent requirements of applicable local code.
- B. Distributed Loads: Design railing assembly, wall rails, and attachments to resist distributed force of 75 pounds per linear foot (1095 N/m) applied to the top of the assembly and in any direction, without damage or permanent set. Test in accordance with ASTM E935
- C. Concentrated Loads: Design railing assembly, wall rails, and attachments to resist a concentrated force of 200 pounds (890 N) applied at any point on the top of the assembly and in any direction, without damage or permanent set. Test in accordance with ASTM E935
- D. Allow for expansion and contraction of members and building movement without damage to connections or members.
- E. Dimensions: See drawings for configurations and heights.
- F. Provide anchors and other components as required to attach to structure, made of same materials as railing components unless otherwise indicated; where exposed fasteners are unavoidable provide flush countersunk fasteners.

- G. Provide slip-on non-weld mechanical fittings to join lengths, seal open ends, and conceal exposed mounting bolts and nuts, including but not limited to elbows, T-shapes, splice connectors, flanges, escutcheons, and wall brackets.
- H. Welded and Brazed Joints: Make visible joints butt tight, flush, and hairline; use methods that avoid discoloration and damage of finish; grind smooth, polish, and restore to required finish.
 - 1. Ease exposed edges to a small uniform radius.
 - 2. Welded Joints:
 - a. Carbon Steel: Perform welding in accordance with AWS D1.1/D1.1M.

2.02 STEEL RAILING SYSTEM

- A. Steel Tube: ASTM A500/A500M Grade B cold-formed structural tubing.
- B. Steel Pipe: ASTM A53/A53M Grade B Schedule 80, black finish.
- C. Non-Weld Mechanical Fittings: Slip-on, galvanized malleable iron castings, for Schedule 40 pipe, with flush setscrews for tightening by standard hex wrench, no bolts or screw fasteners.
- D. Welding Fittings: Factory- or shop-welded from matching pipe or tube; seams continuously welded; joints and seams ground smooth.
- E. Exposed Fasteners: No exposed bolts or screws.
- F. Galvanizing: In accordance with requirements of ASTM A123/A123M.

2.03 FABRICATION

- A. Accurately form components to suit specific project conditions and for proper connection to building structure.
- B. Fit and shop assemble components in largest practical sizes for delivery to site.
- C. Fabricate components with joints tightly fitted and secured. Provide spigots and sleeves to accommodate site assembly and installation.
- D. Welded Joints:
 - 1. Exterior Components: Continuously seal joined pieces by intermittent welds and plastic filler. Drill condensate drainage holes at bottom of members at locations that will not encourage water intrusion.
 - 2. Interior Components: Continuously seal joined pieces by intermittent welds and plastic filler.
 - 3. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field conditions are acceptable and are ready to receive work.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install components plumb and level, accurately fitted, free from distortion or defects, with tight joints.
- C. Install railings in compliance with ADA Standards for accessible design at applicable locations.
- D. Anchor railings securely to structure.

END OF SECTION

**SECTION 06 10 00
ROUGH CARPENTRY**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Structural dimension lumber framing.
- B. Structural composite lumber framing.
- C. Nonstructural dimension lumber framing.
- D. Rough opening framing for doors, windows, and roof openings.
- E. Sheathing.
- F. Preservative treated wood materials.
- G. Fire retardant treated wood materials.
- H. Miscellaneous framing and sheathing.
- I. Communications and electrical room mounting boards.
- J. Concealed wood blocking, nailers, and supports.
- K. Miscellaneous wood nailers, furring, and grounds.

1.02 RELATED REQUIREMENTS

- A. Section 05 50 00 - Metal Fabrications: Miscellaneous steel connectors and support angles for wood framing.
- B. Section 06 17 53 - Shop-Fabricated Wood Trusses.
- C. Section 06 18 00 - Glued-Laminated Construction.
- D. Section 07 27 00 - Air Barriers: Air barrier over sheathing.
- E. Section 07 62 00 - Sheet Metal Flashing and Trim: Sill flashings.

1.03 REFERENCE STANDARDS

- A. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.
- B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2025.
- C. ASTM D2898 - Standard Practice for Accelerated Weathering of Fire-Retardant-Treated Wood for Fire Testing; 2010 (Reapproved 2024).
- D. ASTM D5456 - Standard Specification for Evaluation of Structural Composite Lumber Products; 2021, with Editorial Revision.
- E. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2024.
- F. AWC (WFCM) - Wood Frame Construction Manual for One- and Two-Family Dwellings; 2024, with Errata.
- G. AWPA U1 - Use Category System: User Specification for Treated Wood; 2025.
- H. ICC (IBC) - International Building Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- I. PS 1 - Structural Plywood; 2023.
- J. PS 2 - Performance Standard for Wood Structural Panels; 2018.
- K. PS 20 - American Softwood Lumber Standard; 2025.

- L. WCLIB (GR) - WCLB Standard Grading Rules for West Coast & Imported Softwood Lumber No.18; 2024.
- M. WWPA G-5 - Western Lumber Grading Rules; 2025.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide technical data on insulated sheathing, wood preservative materials, and application instructions.
- C. Structural Composite Lumber: Submit manufacturer's published structural data including span tables, marked to indicate which sizes and grades are being used; if structural composite lumber is being substituted for dimension lumber or timbers, submit grading agency structural tables marked for comparison.
- D. Manufacturer's Certificate: Certify that wood products supplied for rough carpentry meet or exceed specified requirements.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. General: Cover wood products to protect against moisture. Support stacked products to prevent deformation and to allow air circulation.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. Dimension Lumber: Comply with PS 20 and requirements of specified grading agencies.
 - 1. If no species is specified, provide species graded by the agency specified; if no grading agency is specified, provide lumber graded by grading agency meeting the specified requirements.
 - 2. Grading Agency: Grading agency whose rules are approved by the Board of Review, American Lumber Standard Committee at www.alsc.org, and who provides grading service for the species and grade specified; provide lumber stamped with grade mark unless otherwise indicated.

2.02 DIMENSION LUMBER FOR CONCEALED APPLICATIONS

- A. Grading Agency: West Coast Lumber Inspection Bureau; WCLIB (GR).
- B. Grading Agency: Western Wood Products Association; WWPA G-5.
- C. Sizes: Nominal sizes as indicated on drawings, S4S.
- D. Moisture Content: Kiln-dry or MC15.
- E. Stud Framing (2 by 2 through 2 by 6 (50 by 50 mm through 50 by 150 mm)):
 - 1. Species: as indicated on drawings.
 - 2. Grade: No. 2.
- F. Joist, Rafter, and Small Beam Framing (2 by 6 through 4 by 16 (50 by 150 mm through 100 by 400 mm)):
 - 1. Species: as indicated on drawings.
 - 2. Grade: No. 1 and Better.
- G. Miscellaneous Framing, Blocking, Nailers, Grounds, and Furring:
 - 1. Lumber: S4S, No. 2 or Standard Grade.
 - 2. Boards: Standard or No. 3.

2.03 STRUCTURAL COMPOSITE LUMBER

- A. Structural Composite Lumber Materials: Factory-fabricated engineered wood products consisting of wood veneers, strands, or flakes pressed with moisture-resistant adhesive into blocks of material, evaluated in accordance with ASTM D5456.

1. Laminated Veneer Lumber (LVL): Engineered wood products consisting of thin wood veneer bonded together with adhesive with grain of veneers running parallel to long dimension.
 - a. Manufacturer's Published Modulus of Elasticity, E: 1,800,000 psi (12,410 MPa), minimum.

2.04 CONSTRUCTION PANELS

- A. Subfloor/Underlayment Combination: PS 1 type, rated Single Floor.
 1. Panel Type: Plywood.
 2. Bond Classification: Exposure 1.
 3. Performance Category: 3/4 PERF CAT.
 4. Edges: Tongue and groove.
- B. Roof Sheathing: Oriented strand board wood structural panel; PS 2.
 1. Grade: Sheathing.
 2. Bond Classification: Exposure 1.
 3. Performance Category: 5/8 PERF CAT.
- C. Wall Sheathing: Plywood, PS 1, Grade C-D, Exposure I.

2.05 ACCESSORIES

- A. Fasteners and Anchors:
 1. Metal and Finish: Hot-dipped galvanized steel complying with ASTM A153/A153M for high humidity and preservative-treated wood locations, unfinished steel elsewhere.
- B. Die-Stamped Connectors: Hot dipped galvanized steel, sized to suit framing conditions.
 1. For contact with preservative treated wood in exposed locations, provide minimum G185 (Z550) galvanizing complying with ASTM A653/A653M.
 2. Products:
 - a. Simpson Strong Tie.
- C. Sill Gasket on Top of Foundation Wall: 3/8 inch (9.5 mm) thick, closed-cell plastic foam.
 1. Width: match sill plate width.
 2. Ultraviolet (UV) and Weathering Resistance: Approved in writing by manufacturer for up to 30 days of weather exposure.
- D. Sill Flashing: See Section 07 62 00.

2.06 FACTORY WOOD TREATMENT

- A. Treated Lumber and Plywood: Comply with requirements of AWPA U1 - Use Category System for wood treatments determined by use categories, expected service conditions, and specific applications.
 1. Fire-Retardant Treated Wood: Mark each piece of wood with producer's stamp indicating compliance with specified requirements.
 2. Preservative-Treated Wood: Provide lumber and plywood marked or stamped by an ALSC-accredited testing agency, certifying level and type of treatment in accordance with AWPA standards.
- B. Fire Retardant Treatment:
 1. Exterior Type: AWPA U1, Category UCFB, Commodity Specification H, chemically treated and pressure impregnated; capable of providing a maximum flame spread index of 25 when tested in accordance with ASTM E84, with no evidence of significant combustion when test is extended for an additional 20 minutes both before and after accelerated weathering test performed in accordance with ASTM D2898.
 - a. Kiln dry wood after treatment to a maximum moisture content of 19 percent for lumber and 15 percent for plywood.
 - b. Do not use treated wood in direct contact with the ground.

- C. Preservative Treatment:
 - 1. Preservative Pressure Treatment of Lumber Above Grade: AWP A U1, Use Category UC3B, Commodity Specification A using waterborne preservative.
 - a. Kiln dry lumber after treatment to maximum moisture content of 19 percent.
 - 2. Preservative Pressure Treatment of Plywood Above Grade: AWP A U1, Use Category UC2 and UC3B, Commodity Specification F using waterborne preservative.
 - a. Kiln dry plywood after treatment to maximum moisture content of 19 percent.
 - 3. Preservative Pressure Treatment of Lumber in Contact with Soil: AWP A U1, Use Category UC4A, Commodity Specification A using waterborne preservative.
 - a. Preservative for Field Application to Cut Surfaces: As recommended by manufacturer of factory treatment chemicals for brush-application in the field.

PART 3 EXECUTION

3.01 PREPARATION

- A. Where wood framing bears on cementitious foundations, install full width sill flashing continuous over top of foundation, lap ends of flashing minimum of 4 inches (100 mm) and seal.
- B. Install sill gasket under sill plate of framed walls bearing on foundations; puncture gasket cleanly to fit tightly around protruding anchor bolts.
- C. Coordinate installation of rough carpentry members specified in other sections.

3.02 INSTALLATION - GENERAL

- A. Select material sizes to minimize waste.
- B. Reuse scrap to the greatest extent possible; clearly separate scrap for use on site as accessory components, including: shims, bracing, and blocking.
- C. Where treated wood is used on interior, provide temporary ventilation during and immediately after installation sufficient to remove indoor air contaminants.

3.03 FRAMING INSTALLATION

- A. Set structural members level, plumb, and true to line. Discard pieces with defects that would lower required strength or result in unacceptable appearance of exposed members.
- B. Make provisions for temporary construction loads, and provide temporary bracing sufficient to maintain structure in true alignment and safe condition until completion of erection and installation of permanent bracing.
- C. Install structural members full length without splices unless otherwise specifically detailed.
- D. Comply with member sizes, spacing, and configurations indicated, and fastener size and spacing indicated, but not less than required by applicable codes and AWC (WFCM) Wood Frame Construction Manual.
- E. Install horizontal spanning members with crown edge up and not less than 1-1/2 inches (38 mm) of bearing at each end.
- F. Construct double joist headers at floor and ceiling openings and under wall stud partitions that are parallel to floor joists; use metal joist hangers unless otherwise detailed.
- G. Frame wall openings with two or more studs at each jamb; support headers on cripple studs.

3.04 BLOCKING, NAILERS, AND SUPPORTS

- A. Provide framing and blocking members as indicated or as required to support finishes, fixtures, specialty items, and trim.
- B. In framed assemblies that have concealed spaces, provide solid wood fireblocking as required by applicable local code, to close concealed draft openings between floors and between top

story and roof/attic space; other material acceptable to authorities having jurisdiction may be used in lieu of solid wood blocking.

- C. In walls, provide blocking attached to studs as backing and support for wall-mounted items, unless item can be securely fastened to two or more studs or other method of support is explicitly indicated.
- D. Where ceiling-mounting is indicated, provide blocking and supplementary supports above ceiling, unless other method of support is explicitly indicated.
- E. Provide the following specific nonstructural framing and blocking:
 - 1. Cabinets and shelf supports.
 - 2. Wall brackets.
 - 3. Handrails.
 - 4. Grab bars.
 - 5. Towel and bath accessories.
 - 6. Wall-mounted door stops.
 - 7. Chalkboards and marker boards.
 - 8. Wall paneling and trim.
 - 9. Joints of rigid wall coverings that occur between studs.

3.05 INSTALLATION OF CONSTRUCTION PANELS

- A. Subflooring: Glue and nail to framing; staples are not permitted.
- B. Roof Sheathing: Secure panels with long dimension perpendicular to framing members, with ends staggered and over firm bearing.
 - 1. Nail panels to framing; staples are not permitted.
- C. Wall Sheathing: Secure with long dimension perpendicular to wall studs, with ends over firm bearing and staggered, using nails, screws, or staples.
- D. Communications and Electrical Room Mounting Boards: Secure with screws to studs with edges over firm bearing; space fasteners at maximum 24 inches (610 mm) on center on all edges and into studs in field of board.
 - 1. At fire-rated walls, install board over wall board indicated as part of the fire-rated assembly.
 - 2. Where boards are indicated as full floor-to-ceiling height, install with long edge of board parallel to studs.
 - 3. Install adjacent boards without gaps.

3.06 TOLERANCES

- A. Framing Members: 1/4 inch (6 mm) from true position, maximum.
- B. Variation from Plane, Other than Floors: 1/4 inch in 10 feet (2 mm/m) maximum, and 1/4 inch in 30 feet (7 mm in 10 m) maximum.

END OF SECTION

SECTION 06 16 50
EXTERIOR GYPSUM SHEATHING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Wall sheathing.
- B. Roof termination and parapet sheathing.
- C. Exterior gypsum board for soffits.

1.02 SUBMITTALS

- A. Product Data: For each sheathing type, indicate manufacturer's sheathing panels.

1.03 DELIVERY, STORAGE, AND HANDLING

- A. Store sheathing panels flat, under cover, and elevated above grade; store in original shipping packaging; avoid continuous exposure to moisture and direct sunlight.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

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

2.02 WALL SHEATHING

- A. Glass-Mat Gypsum Sheathing: ASTM C1177/C1177M.
 - 1. Manufacturers:
 - a. Georgia-Pacific Gypsum LLC; Dens-Glass Gold.
 - b. National Gypsum Company; Gold Bond eXP Extended Exposure Sheathing.
 - c. USG Corporation; SECUROCK UltraLight Glass-Mat Sheathing Panels.
- B. Type and Thickness: Type X, 5/8 inch thick.

2.03 ROOF TERMINATION AND PARAPET SHEATHING

- A. Glass-Mat Gypsum Sheathing: ASTM C1177/C1177M.
 - 1. Manufacturers:
 - a. Georgia-Pacific Gypsum LLC; Dens-Deck Prime.
 - b. USG Corporation; SECUROCK Coated Glass-Mat Roof Board.
 - 2. Type and Thickness: Type X, 5/8 inch thick.

2.04 EXTERIOR GYPSUM BOARD FOR SOFFITS

- A. Glass-Mat Gypsum Sheathing:
 - 1. Manufacturers:
 - a. Georgia-Pacific Gypsum LLC; ToughRock Fireguard Soffit Board.
 - b. National Gypsum Company; Gold Bond eXP Extended Exposure Sheathing.
 - c. USG Corporation; SHEETROCK Exterior Gypsum Ceiling Board.
 - 2. Type and Thickness: Type X, 5/8 inch thick.

2.05 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
 - 1. For sheathing, provide corrosion-resistant fasteners complying with ASTM C954.
- B. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70 or NES NER-272.

- C. Screws for Fastening Gypsum Sheathing to Cold-Formed Metal Framing: Steel drill screws, in length recommended by sheathing manufacturer for thickness of sheathing to be attached.
 - 1. For steel framing from 0.033 to 0.112 inch thick, use screws that comply with ASTM C954.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install sheathing system panels, components and accessories in accordance with sheathing manufacturer's published instructions.
- B. Attach sheathing to structural base wall system with specified fasteners applicable for substrate type and substrate material thickness.

END OF SECTION

**SECTION 06 17 53
SHOP-FABRICATED WOOD TRUSSES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Shop-fabricated wood trusses.
- B. Truss bridging.

1.02 RELATED REQUIREMENTS

- A. Section 06 10 00 - Rough Carpentry: Installation requirements for miscellaneous framing.
- B. Section 06 10 00 - Rough Carpentry: Material requirements for blocking, bridging, plates, and miscellaneous framing.

1.03 REFERENCE STANDARDS

- A. ANSI/TPI 1 - National Design Standard for Metal-Plate-Connected Wood Truss Construction; 2014.
- B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2025.
- C. SBCA (BCSI) - Building Component Safety Information: Guide to Good Practice for Handling, Installing, Restraining & Bracing of Metal Plate Connected Wood Trusses; 2018 (Updated 2020).
- D. TPI DSB-89 - Recommended Design Specification for Temporary Bracing of Metal Plate Connected Wood Trusses; 1989.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Manufacturer's data sheets on plate connectors, bearing plates, and metal bracing components.
- C. Shop Drawings: Show truss configurations, sizes, spacing, size and type of plate connectors, cambers, framed openings, bearing and anchor details, and bridging and bracing.
 - 1. Include identification of engineering software used for design.
 - 2. Provide shop drawings stamped or sealed by design engineer.
 - 3. Submit design calculations.
- D. Designer's Qualification Statement.
- E. Fabricator's Qualification Statement.

1.05 QUALITY ASSURANCE

- A. Designer Qualifications: Perform design by or under direct supervision of a Professional Engineer experienced in design of this Work and licensed in the State in which the Project is located.
- B. Fabricator Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Handle trusses in accordance with SBCA (BCSI).
- B. Store trusses in vertical position resting on bearing ends.

PART 2 PRODUCTS

2.01 TRUSSES

- A. Wood Trusses: Design and fabricate trusses in accordance with ANSI/TPI 1 and to achieve specified design requirements indicated.

1. Design and fabricate temporary bracing in accordance with TPI DSB-89.
2. Connectors: Steel plate.
3. Structural Design: Comply with applicable code and the drawings for structural loading criteria.

2.02 MATERIALS

- A. Lumber:
 1. Moisture Content: Between 7 and 9 percent.
- B. Steel Connectors: Hot-dipped galvanized steel sheet, ASTM A653/A653M Structural Steel (SS) Grade 33/230, with G90/Z275 coating; die stamped with integral teeth; thickness as indicated.
- C. Truss Bridging: Type, size and spacing recommended by truss manufacturer.

2.03 ACCESSORIES

- A. Wood Blocking, Bridging, Plates, and Miscellaneous Framing: Softwood lumber, any species, construction grade, 19 percent maximum and 7 percent minimum moisture content.
- B. Wood Blocking, Bridging, Plates, and Miscellaneous Framing: As specified in Section 06 10 00.
- C. Bearing Plates: Electrogalvanized steel.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that supports and openings are ready to receive trusses.

3.02 PREPARATION

- A. Coordinate placement of bearing items.

3.03 ERECTION

- A. Install trusses in accordance with manufacturer's instructions, SBCA (BCSI); maintain a copy of applicable documents on site until installation is complete.
- B. Set members level and plumb, in correct position.
- C. Make provisions for erection loads, and for sufficient temporary bracing to maintain structure plumb, and in true alignment until completion of erection and installation of permanent bracing.
- D. Do not field-cut or alter structural members without approval of Architect.
- E. Install permanent bridging and bracing.
- F. Install headers and supports to frame openings required.
- G. Frame openings between trusses with lumber in accordance with Section 06 10 00.

3.04 TOLERANCES

- A. Framing Members: 1/4" inch (6 mm) maximum, from true position.

END OF SECTION

SECTION 06 18 00
GLUED-LAMINATED CONSTRUCTION

PART 1 GENERAL

1.01 REFERENCE STANDARDS

- A. ANSI 117 - Standard Specification for Structural Glued Laminated Timber of Softwood Species; 2020.
- B. ANSI A190.1 - Product Standard for Structural Glued Laminated Timber; 2022.
- C. ICC (IBC) - International Building Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- D. RIS (GR) - Standard Specifications for Grades of California Redwood Lumber; 2019.

1.02 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide technical data.

1.03 DELIVERY, STORAGE, AND HANDLING

- A. Protect members to AITC requirements for not wrapped.

PART 2 PRODUCTS

2.01 GLUED-LAMINATED UNITS

- A. Glued-Laminated Units: Fabricate in accordance with ANSI 117 Industrial grade.
 - 1. Verify dimensions and site conditions prior to fabrication.
 - 2. Cut and fit members accurately to length to achieve tight joint fit.
 - 3. Fabricate member with camber built in.
 - 4. Do not splice or join members in locations other than those indicated without permission.

2.02 MATERIALS

- A. Lumber: Softwood lumber complying with the grades and values shown on the drawings and with 12 percent maximum moisture content before fabrication.

2.03 FABRICATION

- A. Fabricate glue laminated structural members in accordance with AITC Industrial grade.
- B. Cut and fit members accurately to length to achieve tight joint fit.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that supports are ready to receive units.
- B. Verify sufficient end bearing area.

3.02 ERECTION

- A. Lift members using protective straps to prevent visible damage.
- B. Set structural members level and plumb, in correct positions or sloped where indicated.
- C. Provide temporary bracing and anchorage to hold members in place until permanently secured.
- D. Fit members together accurately without trimming, cutting, splicing, or other unauthorized modification.

END OF SECTION

**SECTION 06 20 00
FINISH CARPENTRY**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Finish carpentry items.

1.02 RELATED REQUIREMENTS

- A. Section 06 41 00 - Architectural Wood Casework: Shop fabricated custom cabinet work.
- B. Section 09 91 23 - Interior Painting: Painting of finish carpentry items.
- C. Section 09 93 00 - Staining and Transparent Finishing: Staining and transparent finishing of finish carpentry items.

1.03 REFERENCE STANDARDS

- A. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards, 2nd Edition; 2014, with Errata (2016).
- B. AWMAC/WI (NAAWS) - North American Architectural Woodwork Standards; 2021, with Errata.
- C. HPVA HP-1 - American National Standard for Hardwood and Decorative Plywood; 2024.
- D. PS 1 - Structural Plywood; 2023.

1.04 SUBMITTALS

- A. Product Data:
 - 1. Provide manufacturer's product data, storage and handling instructions for factory-fabricated units.
- B. Shop Drawings: Indicate materials, component profiles, fastening methods, jointing details, and accessories.
 - 1. Provide information as required by AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS).
- C. Samples: Submit two samples of each finished wood trim 6 inch (152 mm) long.

1.05 QUALITY ASSURANCE

- A. Fabricator Qualifications: Company specializing in fabricating the products specified in this section with minimum five years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Protect from moisture damage.

PART 2 PRODUCTS

2.01 FINISH CARPENTRY ITEMS

- A. Quality Standard: Custom Grade, in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), unless noted otherwise.
- B. Interior Woodwork Items:
 - 1. Moldings, Bases, Casings, and Miscellaneous Trim: Clear white pine; prepare for paint finish.
 - 2. Chair rail : Birch; prepare for transparent finish.
 - a. Size: As indicated on Finish Materials legend on Drawings
 - 3. Loose Shelving: Birch plywood; prepare for paint finish.

2.02 SUSTAINABILITY CHARACTERISTICS

- A. Provide sustainably harvested wood, certified or labeled.

2.03 LUMBER MATERIALS

- A. Softwood Lumber: Clear pine, maximum moisture content of 10 percent.

- B. Hardwood Lumber: Birch species, maximum moisture content of 6 percent , of quality suitable for transparent finish.

2.04 SHEET MATERIALS

- A. Softwood Plywood, Not Exposed to View: Any face species, medium density fiberboard core; PS 1 Grade A-B, glue type as recommended for application.
- B. Softwood Plywood, Exposed to View: Face species as indicated, plain sawn, medium density fiberboard core; PS 1 Grade A-B, glue type as recommended for application.
- C. Hardwood Plywood: Face species as indicated, plain sawn, book matched, medium density fiberboard core; HPVA HP-1 Front Face Grade AA, Back Face Grade 1, glue type as recommended for application.

2.05 FASTENINGS

- A. Adhesive for Purposes Other Than Laminate Installation: Suitable for the purpose; not containing formaldehyde or other volatile organic compounds.
- B. Fasteners: Of size and type to suit application; refer to the drawings

2.06 ACCESSORIES

- A. Adhesive: Type recommended by fabricator to suit application.

2.07 HARDWARE

- A. Closet Brackets and Rods:
 - 1. Knappe and Vogt 1195 Series Heavy-Duty Rod & Shelf Brackets.
 - 2. KV 660 Series Commercial Heavy-Duty Round Closet Rod and 730 End Caps.
- B. Shelf Standards: Heavy Duty to match existing, manufactured by Knappe and Vogt.
- C. Shelf Brackets: Heavy Duty to match existing, manufactured by Knappe and Vogt.

2.08 SITE FINISHING MATERIALS

- A. Field Finishing: See Section 09 91 23.

2.09 FABRICATION

- A. Shop assemble work for delivery to site, permitting passage through building openings.
- B. When necessary to cut and fit on site, provide materials with ample allowance for cutting. Provide trim for scribing and site cutting.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install custom fabrications in accordance with AWI/AWMA/CI (AWS) or AWMA/CI (NAAWS) requirements for grade indicated.
- B. Set and secure materials and components in place, plumb and level.
- C. Carefully scribe work abutting other components, with maximum gaps of 1/32 inch (0.79 mm). Do not use additional overlay trim to conceal larger gaps.

3.02 TOLERANCES

- A. Maximum Variation from True Position: 1/16 inch (1.6 mm).
- B. Maximum Offset from True Alignment with Abutting Materials: 1/32 inch (0.79 mm).

END OF SECTION

SECTION 06 41 00
ARCHITECTURAL WOOD CASEWORK

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Specially fabricated cabinet units.
- B. Hardware.

1.02 RELATED REQUIREMENTS

- A. Section 06 10 00 - Rough Carpentry: Support framing, grounds, and concealed blocking.
- B. Section 12 36 00 - Countertops.

1.03 REFERENCE STANDARDS

- A. ANSI A208.1 - American National Standard for Particleboard; 2022.
- B. ANSI A208.2 - Medium Density Fiberboard (MDF) for Interior Applications; 2022.
- C. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards, 2nd Edition; 2014, with Errata (2016).
- D. AWMAC/WI (NAAWS) - North American Architectural Woodwork Standards; 2021, with Errata.
- E. BHMA A156.9 - Cabinet Hardware; 2020.
- F. NEMA LD 3 - High-Pressure Decorative Laminates; 2005.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Convene a preinstallation meeting not less than one week before starting work of this section; require attendance by all affected installers.

1.05 SUBMITTALS

- A. Shop Drawings: Indicate materials, component profiles, fastening methods, jointing details, and accessories.
 - 1. Scale of Drawings: 1-1/2 inch to 1 foot (125 mm to 1 m), minimum.
 - 2. Provide information as required by AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS).
 - 3. Include certification program label.
- B. Product Data: Provide data for hardware accessories.
- C. Samples: Submit actual samples of architectural cabinet construction, minimum 12 inches (300 mm) square, illustrating proposed cabinet and countertop substrate and finish.
- D. Certificate: Submit labels and certificates required by quality assurance and quality control programs.

1.06 QUALITY ASSURANCE

- A. Fabricator Qualifications: Company specializing in fabricating the products specified in this section with minimum five years of documented experience.
 - 1. Single Source Responsibility: Provide and install this work from single fabricator.
- B. Quality Certification:
 - 1. Provide labels or certificates indicating that the installed work complies with AWI/AWMAC/WI (AWS) requirements for grade or grades specified.
 - 2. Provide designated labels on shop drawings as required by certification program.
 - 3. Provide designated labels on installed products as required by certification program.
 - 4. Submit certifications upon completion of installation that verifies this work is in compliance with specified requirements.
 - 5. Replace, repair, or rework all work for which certification is refused.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Protect units from moisture damage.

1.08 FIELD CONDITIONS

- A. During and after installation of custom cabinets, maintain temperature and humidity conditions in building spaces at same levels planned for occupancy.

PART 2 PRODUCTS

2.01 CABINETS

- A. Quality Standard: Custom Grade, in accordance with AWI/AWMAC/WI (AWS), unless noted otherwise.
- B. Plastic Laminate Faced Cabinets: Custom grade.
- C. Cabinets where shown on Drawings:
 - 1. Door and Drawer Front Edge Profiles: Square edge with thin applied band.
 - 2. Adjustable Shelf Loading: 40 psf (19.5 gm/sq cm).
 - 3. Cabinet Style: Flush overlay.
 - 4. Cabinet Doors and Drawer Fronts: Flush style.

2.02 WOOD-BASED COMPONENTS

- A. Wood fabricated from old growth timber is not permitted.

2.03 PANEL CORE MATERIALS

- A. Particleboard: Composite panel composed of cellulosic particles, additives, and bonding system; comply with ANSI A208.1.
 - 1. Grade: M-2; moisture resistance: MR10.
 - 2. Panel Thickness: 1/2 inch (12.7 mm).
- B. Medium Density Fiberboard (MDF): Composite panel composed of cellulosic fibers, additives, and bonding system; cured under heat and pressure; comply with ANSI A208.2.
 - 1. Grade: 115; moisture resistance: MR10.
 - 2. Panel Thickness: 1 inch (25.4 mm).

2.04 THERMALLY FUSED LAMINATE PANELS

- A. Thermally Fused Laminate (TFL): Melamine- or polyester-resin-saturated decorative papers; for fusion to composite wood substrates under heat and pressure.
 - 1. Test in accordance with NEMA LD 3 Section 3.
 - 2. Panel Core Substrate: Particleboard.
 - 3. Color: As selected from manufacturer's standard range of colors.

2.05 LAMINATE MATERIALS

- A. Manufacturers:
 - 1. Basis of Design (PL-1, PL-2, PL-3, PL-4): Provide per the Finish Materials Legend on the Drawings or an equal product from one of the following:
 - 2. Arborite: www.arborite.com/#sle.
 - 3. Formica Corporation: www.formica.com/#sle.
 - 4. Wilsonart LLC: www.wilsonart.com/#sle.
- B. High Pressure Decorative Laminate (HPDL): NEMA LD 3, types as recommended for specific applications.
- C. Colors: As indicated on the Finish Legend.

2.06 COUNTERTOPS

- A. Countertops: See Section 12 36 00.

2.07 ACCESSORIES

- A. Adhesive: Type recommended by fabricator to suit application.

- B. Plastic Edge Banding: Extruded PVC, convex shaped; smooth finish; self locking serrated tongue; of width to match component thickness.
 - 1. Use at all exposed shelf edges.
- C. Fasteners: Size and type to suit application.
- D. Bolts, Nuts, Washers, Lags, Pins, and Screws: Of size and type to suit application; galvanized or chrome-plated finish in concealed locations and stainless steel or chrome-plated finish in exposed locations.
- E. Concealed Joint Fasteners: Threaded steel.
- F. Grommets: Standard plastic grommets for cut-outs, in color to blend with adjacent surface.

2.08 HARDWARE

- A. Hardware: BHMA A156.9, types as recommended by fabricator for quality grade specified.
- B. Adjustable Shelf Supports: Standard side-mounted system using multiple holes for pin supports and coordinated self rests, for nominal 1 inch (25 mm) spacing adjustments.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Knappe & Vogt #345 NP or a comparable product.
- C. Drawer and Door Pulls: "U" shaped wire pull, steel with chrome finish, 4 inch centers ("U" shaped wire pull, steel with chrome finish, 100 mm centers).
 - 1. Basis-of-Design Manufacturer: Subject to compliance with requirements, provide Amerock Bow Pull 19003-SS, 128mm hole center, stainless steel. or a comparable product unless matching existing pulls is required.
- D. Keyed Cabinet Locks: Keyed cylinder, two keys per lock, master keyed, steel with chrome finish.
 - 1. Basis-of-Design Manufacturer: Subject to compliance with requirements, provide Disc tumbler, master-keyed, dull chrome finish by CCL Security Products #0737 and #0738 or a comparable product.
 - a. Provide at hinged doors and drawers, where indicated.
 - b. Provide final keying sequence by Owner.
- E. Drawer Slides:
 - 1. Type: Full extension.
 - 2. Static Load Capacity: Commercial grade.
 - 3. Mounting: Side mounted.
 - 4. Stops: Positive type.
 - 5. Basis-of-Design Manufacturer: Subject to compliance with requirements, provide Blum or a comparable product.
 - a. Blum 563 Tandem Plus Blumotion, 100 lb., undermount with soft close BT51.1901 "Kit" LH/RH Lock Device for 563 slide.
 - b. Blum 769 Movento, 170 lb., with soft close at Trash Cabinets or Lateral Files BT51.7601 "Kit" LH/RH Lock Device for 769 slide.
- F. Hinges: European style concealed self-closing type, steel with nickel-plated finish.
 - 1. Basis-of-Design Manufacturer: Subject to compliance with requirements, provide Blum #71B358E Expando Soft Close or a comparable product.

2.09 FABRICATION

- A. Assembly: Shop assemble cabinets for delivery to site in units easily handled and to permit passage through building openings.
- B. Edging: Fit shelves, doors, and exposed edges with specified edging. Do not use more than one piece for any single length.
- C. Fitting: When necessary to cut and fit on site, provide materials with ample allowance for cutting. Provide matching trim for scribing and site cutting.

- D. Plastic Laminate: Apply plastic laminate finish in full uninterrupted sheets consistent with manufactured sizes. Fit corners and joints hairline; secure with concealed fasteners. Slightly bevel arises.
- E. Matching Laminate Wood Grain: Comply with requirements of quality standard for specified Grade.
- F. Mechanically fasten back splash to countertops as recommended by laminate manufacturer at 16 inches (400 mm) on center.
- G. Provide cutouts for plumbing fixtures. Verify locations of cutouts from on-site dimensions. Prime paint cut edges.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify adequacy of backing and support framing.

3.02 INSTALLATION

- A. Install work in accordance with AWI/AWMAC/WI (AWS) requirements for grade indicated.
- B. Set and secure custom cabinets in place, assuring that they are rigid, plumb, and level.
- C. Use fixture attachments in concealed locations for wall mounted components.
- D. Use concealed joint fasteners to align and secure adjoining cabinet units.
- E. Carefully scribe casework abutting other components, with maximum gaps of 1/32 inch (0.79 mm). Do not use additional overlay trim for this purpose.
- F. Secure cabinets to floor using appropriate angles and anchorages.

3.03 ADJUSTING

- A. Adjust installed work.
- B. Adjust moving or operating parts to function smoothly and correctly.

3.04 CLEANING

- A. Clean casework, counters, shelves, hardware, fittings, and fixtures.

END OF SECTION

**SECTION 06 42 00
WOOD PANELING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Custom wood veneer paneling
- B. Wood panels with laminate finish.

1.02 RELATED REQUIREMENTS

- A. Section 06 10 00 - Rough Carpentry: Grounds and concealed blocking.
- B. Section 09 93 00 - Staining and Transparent Finishing: Field finishing.

1.03 REFERENCE STANDARDS

- A. ANSI A208.1 - American National Standard for Particleboard; 2022.
- B. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2024.
- C. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards, 2nd Edition; 2014, with Errata (2016).
- D. AWMAC/WI (NAAWS) - North American Architectural Woodwork Standards; 2021, with Errata.
- E. HPVA HP-1 - American National Standard for Hardwood and Decorative Plywood; 2024.

1.04 SUBMITTALS

- A. Product Data: Provide data on laminates, fire-retardant treatment materials, and application instructions.
- B. Shop Drawings: Indicate materials, component profiles, fastening methods, jointing details, and accessories.
- C. Samples: Submit two samples of finished plywood, 6 x 6 inch (150 x 150 mm) in size, illustrating wood grain and specified finish.
- D. Certificate: Submit labels and certificates required by quality assurance and quality control programs.

1.05 QUALITY ASSURANCE

- A. Fabricator Qualifications: Company specializing in fabricating the products specified in this section with minimum five years of documented experience.
 - 1. Accredited participant in the specified certification program prior to the commencement of fabrication and throughout the duration of the project.
- B. Quality Certification:
 - 1. Provide labels or certificates indicating that the installed work complies with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS) requirements for grade or grades specified.
 - 2. Provide designated labels on shop drawings as required by certification program.
 - 3. Provide designated labels on installed products as required by certification program.
 - 4. Submit certifications upon completion of installation that verifies this work is in compliance with specified requirements.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

- A. Comply with applicable codes for fire-retardant requirements.

2.02 PANELING

- A. Quality Standard: Custom Grade, in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), unless otherwise indicated.
- B. Veneer Paneling (WP-1):
 - 1. Species: As indicated on the Finish Materials Legend on the drawings.
 - 2. Panels: Veneer of full width and balanced sequence matched.
 - 3. Visible Edges and Reveals: Filled and painted.
 - 4. Outside Corners: Mitered and splined.
- C. Laminate Paneling (WP-2):
 - 1. Finish per Materials Legend on the Drawings.

2.03 WOOD-BASED MATERIALS - GENERAL

- A. Hardwood Plywood: HPVA HP-1 Grade A; veneer core, type of glue recommended for application; of grain quality suitable for transparent finish.
- B. Particleboard: Composed of wood chips, medium density, with waterproof resin binders; of grade to suit application; sanded faces; complying with ANSI A208.1.

2.04 ADHESIVES AND FASTENERS

- A. Adhesives: Type suitable for intended purpose, complying with applicable air quality regulations.
- B. Fasteners: Of size and type to suit application.

2.05 WOOD-TREATMENT PROCESSES

- A. Fire-Retardant Treatment (FR-S Type) for Lumber: Chemically treated and pressure impregnated; capable of providing flame spread index of 25, maximum, and smoke developed index of 450, maximum, when tested in accordance with ASTM E84.

2.06 FABRICATION

- A. Prepare panels for delivery to site, permitting passage through building openings.
- B. Finish exposed edges of panels as specified by grade requirements.

2.07 ACCESSORIES

- A. Metal Trim: As indicated on the drawings
- B. Wood Filler: Tinted to match surface finish color.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install work in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS) requirements for grade indicated.
- B. Do not begin installation until wood materials have been fully acclimated to interior conditions.
- C. Set and secure materials and components in place, plumb and level, using concealed fasteners wherever possible.

3.02 PREPARATION FOR FIELD FINISHING

- A. Set exposed fasteners. Apply wood filler in exposed fastener indentations. Sand work smooth.
- B. Field Finishing: See Section 09 93 00.

END OF SECTION

**SECTION 06 64 00
PLASTIC PANELING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Plastic panel walls assemblies.

1.02 REFERENCE STANDARDS

- A. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2024.
- B. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi; 2015, with Editorial Revision (2021).

1.03 SUBMITTALS

- A. Product Data: For each panel and trim type.
- B. Shop Drawings:
 - 1. For each wall paneling layout, indicate:
 - a. Elevations: Dimensioned locations of panels. Include field measurements indicating extents of paneling.
 - b. Drawing Scale: 1/4 inch to 1 foot (1:50), minimum.
 - 2. Details: Include panel attachments to supporting construction.
- C. Samples: For each wall panel type, two samples, 6 inches by 6 inches (150 mm by 150 mm) in size, indicating specified color and pattern.
- D. Samples: For each trim type, two samples, 4 inches (101 mm) in length, indicating specified color and texture.
- E. Installer's qualification statement.

1.04 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site in manufacturer's original, unopened packaging, with labels clearly identifying product name and manufacturer.
- B. Store products in clean, dry, interior areas in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Plastic Paneling (WP-4):
 - 1. Basis of Design: As indicated on the Finish Materials Legend on the Drawings.
- B. Compact Laminate Paneling (WP-8, WP-7):
 - 1. Basis of Design: As indicated on the Finish Materials Legend on the Drawings.

2.02 PLASTIC PANELING

- A. Material: Acrylic.
- B. Surface Burning Requirements, Interior Use: Flame spread index of 25 or less and smoke-development index of 450 or less; Class A classification when tested in accordance with ASTM E84.
- C. Fungi Resistance: No visible growth, when tested in accordance with ASTM G21.
- D. Attachment: Refer to drawings.

- E. Panel Size and Layout: As provided by Architect.

2.03 COMPACT LAMINATE PANELING

- A. Thickness: 1/4 inch.
- B. Composition: Double-sided.
- C. Attachment: Perimeter fastened with edge moldings:
 - 1. Aluminum extrusions: J-channel, H-moldings, inside and outside corner moldings.
- D. Panel Size and Layout: As provided by Architect.

2.04 ACCESSORIES

- A. Stainless steel standoffs for plastic paneling.

PART 3 EXECUTION

3.01 PREPARATION

- A. Surface Preparation: Clean substrate surfaces prior to installing paneling.

3.02 INSTALLATION - GENERAL

- A. Maintain manufacturer recommended gap tolerances between panels and adjacent abutments.
- B. Field-cut panels in accordance with manufacturer's written instructions. Make straight and square cuts; do not damage panels.

3.03 INSTALLATION - PLASTIC PANEL WALLS

- A. Install panels in accordance with manufacturer's written instructions.
- B. Install panel layout as indicated on approved shop drawings.
- C. Install wall panels plumb within specified tolerances.

3.04 CLEANING

- A. Clean exposed surfaces of panels and trim in accordance with manufacturer's instructions.

3.05 PROTECTION

- A. Protect installed plastic paneling from subsequent construction operations.

END OF SECTION

**SECTION 07 14 00
FLUID-APPLIED WATERPROOFING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Polyurethane waterproofing.

1.02 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-in-Place Concrete: Concrete substrate.

1.03 REFERENCE STANDARDS

- A. ASTM C836/C836M - Standard Specification for High Solids Content, Cold Liquid-Applied Elastomeric Waterproofing Membrane for Use with Separate Wearing Course; 2018 (Reapproved 2022).
- B. ASTM D412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers--Tension; 2016 (Reapproved 2021).
- C. ASTM D2240 - Standard Test Method for Rubber Property--Durometer Hardness; 2015 (Reapproved 2021).
- D. ASTM D4541 - Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers; 2022.
- E. NRCA (WM) - The NRCA Waterproofing Manual; 2021.

1.04 SUBMITTALS

- A. Product Data: Provide data for membrane, surface conditioner, flexible flashings, joint cover sheet, and joint and crack sealants.
- B. Installer's qualification statement.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience.

1.06 FIELD CONDITIONS

- A. Maintain ambient temperatures above 40 degrees F (5 degrees C) for 24 hours before and during application and until cured.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Polyurethane Waterproofing:
 - 1. Basis of Design: Provide Sikalastic 320 NS by Sika Corporation or an equal product by one of the following:
 - 2. Carlisle Coatings & Waterproofing, Inc: www.carlisleccw.com/#sle.
 - 3. Henry Company: www.henry.com/#sle.
 - 4. Tremco Commercial Sealants & Waterproofing: www.tremcosealants.com/#sle.

2.02 FLUID-APPLIED WATERPROOFING APPLICATIONS

- A. Polyurethane Waterproofing:
 - 1. Location: Foundation.

2.03 FLUID-APPLIED WATERPROOFING MATERIALS

- A. Polyurethane Waterproofing: Cold-applied, high solids content polyurethane waterproofing complying with ASTM C836/C836M.
 - 1. Cured Thickness: 60 mil, 0.060 inch (1.52 mm), minimum.

2. Tensile Strength: 400 psi (2.758 MPa), minimum, measured in accordance with ASTM D412.
3. Ultimate Elongation: 168 percent, minimum, measured in accordance with ASTM D412.
4. Durometer Hardness, Type A: 30, minimum, in accordance with ASTM D2240.
5. Adhesion: 150 psi (1.03 MPa), minimum, measured in accordance with ASTM D4541.

2.04 ACCESSORIES

- A. Sealant for Joints and Cracks in Substrate: Type compatible with waterproofing material and as recommended by waterproofing manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify substrate surfaces are free of frozen matter, dampness, loose particles, cracks, pits, projections, penetrations, or foreign matter detrimental to adhesion or application of waterproofing system.
- C. Verify that substrate surfaces are smooth, free of honeycomb or pitting, and not detrimental to full contact bond of waterproofing materials.

3.02 PREPARATION

- A. Clean and prepare surfaces to receive waterproofing in accordance with manufacturer's instructions.
- B. Fill non-moving joints and cracks with a filler compatible with waterproofing materials.
- C. Seal moving cracks with sealant and non-rigid filler, using procedures recommended by sealant and waterproofing manufacturers.

3.03 INSTALLATION

- A. Install waterproofing to specified minimum thickness in accordance with manufacturers instructions and NRCA (WM) applicable requirements.
- B. Seal membrane and flashings to adjoining surfaces.

END OF SECTION

**SECTION 07 19 00
WATER REPELLENTS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Water repellents applied to exterior, masonry surfaces.

1.02 SUBMITTALS

- A. Product Data: Provide product description, details of tests performed, limitations, and chemical composition.
- B. Installer's Qualification Statement.

1.03 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing work of type specified and with at least three years of documented experience

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Silane-Siloxane Blend Water Repellents:
 - 1. Basis of Design: Sikagard H 185 by Sika Corporation or an equal product by one of the following:
 - 2. Evonik Corporation: www.evonik.com/#sle.
 - 3. Pecora Corporation: www.pecora.com/#sle.
 - 4. PROSOCO, Inc: www.prosoco.com/#sle.
 - 5. W. R. Meadows, Inc: www.wrmeadows.com/#sle.

2.02 MATERIALS

- A. Water Repellent: Non-glossy, colorless, penetrating, water-vapor-permeable, non-yellowing sealer, that dries invisibly leaving appearance of substrate unchanged.
 - 1. Applications: Vertical surfaces and non-traffic horizontal surfaces.
 - 2. Water-based siloxane, silane, or blend that reacts chemically with concrete and masonry.

PART 3 EXECUTION

3.01 PREPARATION

- A. Prepare surfaces to be coated as recommended by water repellent manufacturer for best results.

3.02 APPLICATION

- A. Apply water repellent in accordance with manufacturer's instructions, using procedures and application methods recommended as producing the best results.
- B. Apply at rate recommended by manufacturer, continuously over entire surface.
- C. Apply two coats, minimum.
- D. Remove water repellent from unintended surfaces immediately by a method instructed by water repellent manufacturer.

END OF SECTION

**SECTION 07 21 00
THERMAL INSULATION**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Board insulation at perimeter foundation wall and exterior wall behind masonry veneer and metal panel wall finish.
- B. Unfaced glass fiber batt thermal and acoustic insulation.
- C. Mineral wool batt insulation in exterior wall and roof construction.

1.02 REFERENCE STANDARDS

- A. ASTM C578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation; 2023.
- B. ASTM C665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing; 2024.
- C. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2024.
- D. ASTM E136 - Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750 Degrees C; 2024c.

1.03 SUBMITTALS

- A. Product Data: Provide data on product characteristics, performance criteria, and product limitations.
- B. ABAA Manufacturer Qualification: Submit documentation of current evaluation of proposed manufacturer and materials.

1.04 QUALITY ASSURANCE

- A. Air Barrier Association of America (ABAA) Evaluated Materials Program (EAP); www.airbarrier.org/#sle: Use evaluated materials from a single manufacturer regularly engaged in air barrier material manufacture. Use secondary materials approved in writing by primary material manufacturer.

PART 2 PRODUCTS

2.01 APPLICATIONS

- A. Insulation at Perimeter of Foundation: Extruded polystyrene (XPS) board.
- B. Insulation Over Metal Stud Framed Walls, Continuous: Mineral fiber board.
- C. Insulation in Metal Framed Walls: Batt insulation with no vapor retarder.
- D. Insulation Under Roof Deck: Batt insulation with separate vapor retarder.

2.02 FOAM BOARD INSULATION MATERIALS

- A. Extruded Polystyrene (XPS) Board Insulation: Comply with ASTM C578 with either natural skin or cut cell surfaces.
 - 1. Flame Spread Index (FSI): Class A - 0 to 25, when tested in accordance with ASTM E84.
 - 2. Smoke Developed Index (SDI): 450 or less, when tested in accordance with ASTM E84.
 - 3. Type and Thermal Resistance, R-value (RSI-value): Type IV, 5.0 (0.88), minimum, per 1 inch (25.4 mm) thickness at 75 degrees F (24 degrees C) mean temperature.
 - 4. Products:
 - a. Owens Corning Corporation; FOAMULAR NGX Type 150 Next Generation Extruded: www.ocbuildingspec.com/#sle.
 - 5. Location: Outside of stem wall to top of footing.

2.03 MINERAL FIBER BOARD INSULATION MATERIALS

- A. Mineral Wool Board Thermal Insulation: Complying with ASTM C612.
 - 1. Facing: None, unfaced.
 - 2. Flame Spread Index: 25 or less, when tested with facing, if any, in accordance with ASTM E84.
 - 3. Smoke Developed Index: 50 or less, when tested with facing, if any, in accordance with ASTM E84.
 - 4. Board Size: 48 by 48 inches (1220 by 1220 mm).
 - 5. Board Thickness: As required to meet R value on drawings.
 - 6. Board Edges: Square.
 - 7. Products:
 - a. Basis of Design: Owens Corning Corporation; RainBarrier HC: www.ocbuildingspec.com/#sle.

2.04 INSULATION MATERIALS

- A. Flexible Glass Fiber Blanket Thermal /Acoustic Insulation: Preformed insulation, complying with ASTM C665; friction fit.
 - 1. Flame Spread Index: 25 or less, when tested in accordance with ASTM E84.
 - 2. Smoke Developed Index: 50 or less, when tested in accordance with ASTM E84.
 - 3. Combustibility: Non-combustible, when tested in accordance with ASTM E136, except for facing, if any.
 - 4. Formaldehyde Content: Zero.
 - 5. Thickness: Same as stud depth or as indicated.
 - 6. Manufacturer:
 - a. CertainTeed Corporation: www.certainteed.com/#sle.
 - b. Johns Manville: www.jm.com/#sle.
 - c. Owens Corning Corporation: www.ocbuildingspec.com/#sle.
- B. Mineral Wool Blanket Thermal /Acoustic Insulation: Flexible , unfaced, preformed insulation, complying with ASTM C665.
 - 1. Flame Spread Index: 0 (zero), when tested in accordance with ASTM E84.
 - 2. Smoke Developed Index: 0 (zero), when tested in accordance with ASTM E84.
 - 3. Products:
 - a. Basis of Design: Owens Corning Corporation: Thermafiber Fire & Sound Guard Plus Formaldehyde-Free insulation: www.ocbuildingspec.com/#sle or an equal by one of the following:
 - b. Johns Manville: www.jm.com/#sle.
 - c. ROCKWOOL: www.rockwool.com/#sle.

2.05 ACCESSORIES

- A. Interior Vapor Retarder: Modified polyethylene/polyacrylate (PE/PA) film reinforced with polyethylene terephthalate (PET) fibers, 12 mil, 0.012 inch (0.30 mm) thick.
 - 1. Width: 4.9 feet (1.5 m).
 - 2. Products:
 - a. SIGA Cover Inc; SIGA-Majrex 200: www.siga.swiss/global_en/#sle.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that substrate, adjacent materials, and insulation materials are dry and that substrates are ready to receive insulation.
- B. Verify substrate surfaces are flat, free of honeycomb, fins, or irregularities.

3.02 BOARD INSTALLATION AT FOUNDATION PERIMETER

- A. Install boards horizontally on foundation perimeter.

- B. Cut and fit insulation tightly to protrusions or interruptions to the insulation plane.

3.03 BOARD INSTALLATION AT EXTERIOR WALLS

- A. Install boards horizontally on walls.
- B. Cut and fit insulation tightly to protrusions or interruptions to the insulation plane.

3.04 BATT INSTALLATION

- A. Install insulation in accordance with manufacturer's instructions.
- B. Install in exterior wall spaces without gaps or voids. Do not compress insulation.
- C. Trim insulation neatly to fit spaces. Insulate miscellaneous gaps and voids.
- D. Fit insulation tightly in cavities and tightly to exterior side of mechanical and electrical services within the plane of the insulation.
- E. Install with factory-applied vapor retarder membrane facing warm side of building spaces. Lap ends and side flanges of membrane over framing members.
- F. Tape seal butt ends, lapped flanges, and tears or cuts in membrane.

3.05 PROTECTION

- A. Do not permit installed insulation to be damaged prior to its concealment.

END OF SECTION

**SECTION 07 21 19
FOAMED-IN-PLACE INSULATION**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Foamed-in-place insulation.
 - 1. In underside of roof as indicated on drawings.

1.02 REFERENCE STANDARDS

- A. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 2021.
- B. ASTM D2842 - Standard Test Method for Water Absorption of Rigid Cellular Plastics; 2025.
- C. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2024.
- D. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2024a.
- E. ASTM E2178 - Standard Test Method for Determining Air Leakage Rate and Calculation of Air Permeance of Building Materials; 2021a.

1.03 SUBMITTALS

- A. Product Data: Provide product description, insulation properties, and preparation requirements.
- B. Installer Qualification: Submit documentation of current contractor accreditation and current installer certification. Keep copies of all contractor accreditation and installer certification on site during and after installation. Present on-site documentation upon request.

1.04 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing work of the type specified, with minimum three years documented experience.

1.05 FIELD CONDITIONS

- A. Do not apply foam when temperature is below that specified by the manufacturer for ambient air and substrate.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Foamed-In-Place Insulation:
 - 1. Basis of Design: Provide BASF Corporation; WALLTITE US Series Closed Cell: www.spf.basf.com/#sle or an equal product by one of the following:
 - 2. Henry, a Carlisle Company: www.henry.com/#sle.
 - 3. Johns Manville: www.jm.com/#sle.

2.02 MATERIALS

- A. Foamed-In-Place Insulation: Medium-density, rigid or semi-rigid, closed cell polyurethane foam; foamed on-site, using blowing agent of water or non-ozone-depleting gas.
 - 1. Thermal Resistance: R-value (RSI-value) of 7.1 (1.25), minimum, per 1-inch (25.4 mm) thickness at 75 degrees F (24 degrees C) mean temperature when tested in accordance with ASTM C518.
 - 2. Water Vapor Permeance: Vapor retarder; 2 perms (115 ng/(Pa s sq m)), maximum, when tested at intended thickness in accordance with ASTM E96/E96M, desiccant method.
 - 3. Water Absorption: Less than 2 percent by volume, maximum, when tested in accordance with ASTM D2842.
 - 4. Air Permeance: 0.04 cfm per square foot (0.2 L/(s/sq m)), maximum, when tested at intended thickness in accordance with ASTM E2178 at 1.57 psf (75 Pa).

5. Closed Cell Content: At least 90 percent.
6. Surface Burning Characteristics: Flame spread/smoke developed index of 25/450, maximum, when tested in accordance with ASTM E84.

PART 3 EXECUTION

3.01 APPLICATION

- A. Apply insulation in accordance with manufacturer's instructions.

3.02 PROTECTION

- A. Do not permit subsequent construction work to disturb applied insulation.

END OF SECTION

**SECTION 07 26 16
UNDER SLAB VAPOR RETARDERS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Vapor retarders.

1.02 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-in-Place Concrete.

1.03 DEFINITIONS

- A. Vapor Retarder: Airtight barrier made of material that is relatively water vapor impermeable, to degree specified, with seams and joints sealed to adjacent surfaces.
- B. Vapor Retarder Class: A measure of a material or assembly's ability to limit the amount of moisture that passes through that material or assembly. Vapor retarder class is defined using Procedure A, Desiccant Method at 73 degrees F (23 degrees C) and 50 percent Relative Humidity (RH), in accordance with ASTM E96/E96M and ICC (IBC)-2018, as follows:
 - 1. Class I: 0.1 perm or less.
 - 2. Class II: Greater than 0.1 perm to 1.0 perm.
 - 3. Class III: Greater than 1.0 perm to 10 perms.

1.04 REFERENCE STANDARDS

- A. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2024a.
- B. ICC (IBC)-2018 - International Building Code; 2018.

1.05 SUBMITTALS

- A. See Section 01 30 00-Administrative Requirements for submittal procedures.
- B. Product Data: Provide data on material characteristics, performance criteria, and limitations.
- C. Manufacturer's Installation Instructions: Indicate preparation, installation methods, and storage and handling criteria.
- D. Installer's qualification statement.
- E. Testing agency qualification statement.

1.06 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing the work of this section with minimum three years documented experience.
- B. Testing Agency Qualifications: Independent firm specializing in performing testing and inspections of the type specified in this section.

1.07 FIELD CONDITIONS

- A. Maintain temperature and humidity recommended by materials manufacturers before, during, and after installation.

PART 2 PRODUCTS

2.01 VAPOR RETARDERS

- A. Under Slab Vapor Retarder Sheet: Butyl, black color.
 - 1. Sheet Vapor Barrier, Class A: ASTM E1745, Class A.
 - 2. Thickness: 15 mil (0.38 mm) minimum.
 - 3. Water Vapor Permeance: 0.1 perm (5.7 ng/(Pa s sq m)), maximum, when tested in accordance with ASTM E96/E96M.

4. Seam Lap and Perimeter Adhesive: Elastomeric, same composition as sheet or other compatible material.
5. Products:
 - a. Carlisle Coatings & Waterproofing, Inc.; Blackline 400.
 - b. Fortifiber Building Systems Group; Moistop Ultra 15.
 - c. Grace Construction Products, W. R. Grace & Co.; Florprufe 120.
 - d. Meadows, W. R., Inc.; Perminator 15 mil.
 - e. Raven Industries Inc.; Vapor Block 15.
 - f. Reef Industries; Griffolyn; Type-15.
 - g. Stego Industries, LLC; Stego Wrap 15 mil Class A.
 - h. See Section 01 30 00-Administrative Requirements for submittal procedures.

2.02 ACCESSORIES

- A. Sealants, Tapes, and Accessories for Sealing Vapor Retarder and Adjacent Substrates: As indicated, complying with vapor retarder manufacturer's installation instructions.
- B. Vapor Retarder Tape: Pressure-sensitive tape of type recommended by vapor barrier manufacturer for sealing seams, joints, and penetrations in vapor barrier.
 1. Minimum Width: 3.75 inches.
- C. Pressure-sensitive texture tape recommended by vapor barrier manufacturer for sealing vapor barrier to wet concrete.
- D. Double-sided tape recommended by vapor barrier manufacturer for sealing vapor barrier to concrete surfaces.
- E. Minimum Width: 2 inches.
- F. Mastic for Vapor Barrier: Product recommended by vapor barrier manufacturer that has demonstrated capability to bond to vapor barrier and seal penetrations.
- G. Pipe Penetration Boots: Product recommended by vapor barrier manufacturer with a water-vapor permeance of less than 0.3 perms.
- H. Stake Base: Product recommended by vapor barrier manufacturer accepting blunt-end or threaded nail stakes for non-permanent penetration prevention during screeding and formwork.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that surfaces and conditions comply with requirements of this section.

3.02 PREPARATION

- A. Remove projections, protruding fasteners, and loose or foreign matter that might interfere with proper installation.

3.03 INSTALLATION

- A. Install materials in accordance with manufacturer's installation instructions.
- B. Vapor Retarders: Install continuous airtight barrier over surfaces indicated, with sealed seams and sealed joints to adjacent surfaces.
- C. Apply sealants and adhesives within recommended temperature range in accordance with manufacturer's installation instructions.
- D. Self-Adhered Sheets:
 1. Prepare substrate in accordance with sheet manufacturer's installation instructions; fill and tape joints in substrate and between dissimilar materials.
 2. Lap sheets shingle fashion to shed water and seal laps airtight.
 3. Once sheets are in place, press firmly into substrate with resilient hand roller; ensure that laps are firmly adhered with no gaps or fishmouths.

4. Use same material, or other material approved by sheet manufacturer, to seal sheets to adjacent substrates, and as flashing.
 5. At expansion joints, provide transition to joint assemblies approved by sheet manufacturer.
- E. Openings and Penetrations in Exterior Vapor Retarders:
1. Install flashing over sills, covering entire sill framing member, and extend at least 5 inches (127 mm) onto vapor retarder and at least 6 inches (152 mm) up jambs; mechanically fasten stretched edges.
 2. At openings with frames having nailing flanges, seal head and jamb flanges using a continuous bead of sealant compressed by flange and cover flanges with sealing tape at least 4 inches (100 mm) wide; do not seal sill flange.
 3. At openings with nonflanged frames, seal vapor retarder to each side of framing at opening using flashing at least 9 inches (230 mm) wide, and covering entire depth of framing.
 4. At head of openings, install flashing under vapor retarder extending at least 2 inches (50 mm) beyond face of jambs; seal vapor retarder to flashing.
 5. At interior face of openings, seal gaps between window/door frame and rough framing using appropriate joint sealant over backer rod.
 6. Service and Other Penetrations: Form flashing around penetrating items and seal to surface of vapor retarder.

3.04 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements for additional requirements.
- B. Owner's Inspection and Testing: Cooperate with Owner's testing agency.
 1. Allow access to work areas and staging.
 2. Notify Owner's testing agency in writing of schedule for work of this section to allow sufficient time for testing and inspection.
 3. Do not cover work of this section until testing and inspection is accepted.
- C. Do not cover installed vapor retarders until required inspections have been completed.

3.05 PROTECTION

- A. Do not leave materials exposed to weather longer than recommended by manufacturer.

END OF SECTION

**SECTION 07 27 00
AIR BARRIERS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Air barriers.

1.02 RELATED REQUIREMENTS

- A. Section 06 16 50 - Exterior Gypsum Sheathing: Air barrier under exterior cladding.

1.03 DEFINITIONS

- A. Air Barrier: Airtight barrier made of material that is virtually air impermeable but water vapor permeable, both to amount as specified, with sealed seams and sealed joints to adjacent surfaces.

1.04 REFERENCE STANDARDS

- A. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2024a.
- B. ASTM E2178 - Standard Test Method for Determining Air Leakage Rate and Calculation of Air Permeance of Building Materials; 2021a.

1.05 SUBMITTALS

- A. Product Data: Provide data on material characteristics, performance criteria, and limitations.
- B. Installer's qualification statement.

1.06 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing the work of this section with minimum three years experience.

1.07 FIELD CONDITIONS

- A. Maintain temperature and humidity recommended by materials manufacturers before, during, and after installation.

PART 2 PRODUCTS

2.01 AIR BARRIER MATERIALS (AIR IMPERMEABLE AND WATER VAPOR PERMEABLE)

- A. Air Barrier, Fluid-Applied: Vapor permeable, elastomeric waterproofing.
 - 1. Air Barrier Coating:
 - a. Material: Silica-fortified rubber.
 - b. Dry Film Thickness (DFT): 10 mil, 0.010 inch (0.254 mm), minimum.
 - c. Air Permeance: 0.004 cfm/sq ft (0.02 L/(s sq m)), maximum, when tested in accordance with ASTM E2178.
 - d. Water Vapor Permeance: 18 perms (1025 ng/(Pa s sq m)), minimum, when tested in accordance with ASTM E96/E96M using Procedure B - Water Method, at 73.4 degrees F (23 degrees C).
 - e. Products:
 - 1) Basis of Design: Provide Sikagard AWB 660 or an equal product by one of the following manufacturers.
 - (a) Dow Chemical Company: consumer.dow.com/en-us/industry/ind-building-construction.html/#sle.
 - (b) GCP Applied Technologies: www.gcpat.com/#sle.
 - (c) Pecora Corporation: www.pecora.com/#sle.
 - (d) Soprema, Inc: www.soprema.us/#sle.

2.02 ACCESSORIES

- A. Sealants, Tapes, and Accessories for Sealing Air Barrier and Adjacent Substrates: As indicated or in compliance with air barrier manufacturer's installation instructions.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install materials in accordance with manufacturer's installation instructions.
- B. Air Barriers: Install continuous airtight barrier over surfaces indicated, with sealed seams and with sealed joints to adjacent surfaces.
- C. Apply sealants and adhesives within recommended temperature range in accordance with manufacturer's installation instructions.
- D. Fluid-Applied Coatings or Membranes:
1. Prepare substrate in accordance with manufacturer's installation instructions; treat joints in substrate and between dissimilar materials as indicated.
 2. Use flashing to seal to adjacent construction and to bridge joints in coating substrate.
- E. Openings and Penetrations in Exterior Air Barriers:
1. Install flashing over sills, covering entire sill frame member, extending at least 5 inches (125 mm) onto air barrier and at least 6 inches (150 mm) up jambs; mechanically fasten stretched edges.
 2. At openings with frames having nailing flanges, seal head and jamb flanges using a continuous bead of sealant compressed by flange and cover flanges with sealing tape at least 4 inches (100 mm) wide; do not seal sill flange.
 3. At openings with nonflanged frames, seal air barrier to each side of framing at opening using flashing at least 9 inches (230 mm) wide, and covering entire depth of framing.
 4. At head of openings, install flashing under air barrier extending at least 2 inches (50 mm) beyond face of jambs; seal air barrier to flashing.
 5. At interior face of openings, seal gap between window/door frame and rough framing, using joint sealant over backer rod.
 6. Service and Other Penetrations: Form flashing around penetrating item and seal to air barrier surface.

3.02 PROTECTION

- A. Do not leave materials exposed to weather longer than recommended by manufacturer.

END OF SECTION

**SECTION 07 41 13
METAL ROOF PANELS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Metal roof panel system of preformed steel panels.
- B. Underlayment.

1.02 RELATED REQUIREMENTS

- A. Section 07 21 00 - Thermal Insulation: Rigid roof insulation.
- B. Section 07 62 00 - Sheet Metal Flashing and Trim: Counterflashing and reglets.
- C. Section 07 92 00 - Joint Sealants: Sealing joints between metal roof panel system and adjacent construction.

1.03 REFERENCE STANDARDS

- A. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix); 2022.
- B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2025.
- C. ASTM D1970/D1970M - Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection; 2021.
- D. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2024a.
- E. ASTM E1592 - Standard Test Method for Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference; 2005 (Reapproved 2017).

1.04 SUBMITTALS

- A. Product Data: Manufacturer's data sheets on each product to be used, including:
 - 1. Storage and handling requirements and recommendations.
 - 2. Installation methods.
 - 3. Specimen warranty.
- B. Shop Drawings: Include layouts of roof panels, details of edge and penetration conditions, spacing and type of connections, flashings, underlayments, and special conditions.
 - 1. Show work to be field-fabricated or field-assembled.
- C. Selection Samples: For each roofing system specified, submit color chips representing manufacturer's full range of available colors and patterns.
- D. Verification Samples: For each roofing system specified, submit samples of minimum size 12 inches (305 mm) square, representing actual roofing metal, thickness, profile, color, and texture.
- E. Installer's qualification statement.
- F. Test Reports: Indicate compliance of metal roofing system to specified requirements.
- G. Warranty: Submit specified manufacturer's warranty and ensure that forms have been completed in Owner's name and are registered with manufacturer.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Store roofing panels on project site as recommended by manufacturer to minimize damage to panels prior to installation.

1.07 FIELD CONDITIONS

- A. Do not install metal roof panels, when surface, ambient air, or wind chill temperatures are below 45 degrees F (7 degrees C).

1.08 WARRANTY

- A. Finish Warranty: Provide 5-year manufacturer warranty against excessive degradation of exterior finish. Include provision for replacement of units with excessive fading, chalking, or flaking. Complete forms in Owner's name and register with warrantor.
- B. Special Warranty: Provide 2-year warranty for weathertightness of roofing system, including agreement to repair or replace metal roof panels that fail to keep out water commencing on the Date of Substantial Completion. Complete forms in Owner's name and register with warrantor.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Architectural Metal Roof Panel Manufacturers:
 - 1. Basis of Design: Provide Western Lock - Snap Lock Standing Seam Metal Roofing or an equal product by one of the following:
 - a. Elevate: www.holcimelevate.com/#sle.
 - b. MBCI, a Cornerstone Building Brands Company; 5V Crimp Panel: www.mbc.com/#sle.
 - c. Morin Corporation: www.morincorp.com/#sle.

2.02 PERFORMANCE REQUIREMENTS

- A. Metal Roof Panels: Provide complete roofing assemblies, including roof panels, clips, fasteners, connectors, and miscellaneous accessories, tested for compliance with the following minimum standards:
 - 1. Structural Design Criteria: Provide panel assemblies designed to safely support design loads at support spacing indicated, with deflection not to exceed L/180 of span length(L) when tested in accordance with ASTM E1592.
 - 2. Overall: Complete weathertight system tested and approved in accordance with ASTM E1592.
 - 3. Thermal Movement: Design system to accommodate without deformation anticipated thermal movement over ambient temperature range of 100 degrees F (56 degrees C).

2.03 METAL ROOF PANELS

- A. Metal Roof Panels: Provide complete engineered system complying with specified requirements and capable of remaining weathertight while withstanding anticipated movement of substrate and thermally induced movement of roofing system.
- B. Metal Panels: Factory-formed panels with factory-applied finish.
 - 1. Steel Panels:
 - a. Zinc-coated steel complying with ASTM A653/A653M; minimum G60 (Z180) galvanizing.
 - b. Steel Thickness: Minimum 24 gauge, 0.024 inch (0.61 mm).
 - 2. Profile: Standing seam, with minimum 1.75-inch (44.45 mm) seam height; concealed fastener system for field seaming with special tool.
 - 3. Texture: Smooth.
 - 4. Width: Maximum panel coverage of 18 inches (457 mm).

2.04 ATTACHMENT SYSTEM

- A. Concealed System: Provide manufacturer's standard stainless steel or nylon-coated aluminum concealed anchor clips designed for specific roofing system and engineered to meet performance requirements, including anticipated thermal movement.

2.05 FABRICATION

- A. Panels: Provide factory fabricated panels with applied finish and accessory items, using manufacturer's standard processes as required to achieve specified appearance and performance requirements.
- B. Joints: Provide captive gaskets, sealants, or separator strips at panel joints to ensure weathertight seals, eliminate metal-to-metal contact, and minimize noise from panel movements.

2.06 FINISHES

- A. Fluoropolymer Coil Coating System: Polyvinylidene fluoride (PVDF) multi-coat superior performing organic coatings system complying with AAMA 2605, including at least 70 percent PVDF resin, and at least 80 percent of coil coated metal surfaces having minimum total dry film thickness (DFT) of 0.9 mil, 0.0009 inch (0.023 mm); custom color and gloss as selected by Architect.

2.07 ACCESSORIES

- A. Miscellaneous Sheet Metal Items: Provide flashings, trim, moldings, closure strips, and caps of the same material, thickness, and finish as used for the roofing panels. Items completely concealed after installation may optionally be made of stainless steel.
- B. Rib and Ridge Closures: Provide prefabricated, close-fitting components of steel with corrosion resistant finish or combination steel and closed-cell foam.
- C. Sealants:
 - 1. Exposed Sealant: Elastomeric; silicone, polyurethane, or silyl-terminated polyether/polyurethane.
 - 2. Concealed Sealant: Non-curing butyl sealant or tape sealant.
 - 3. Seam Sealant: Factory-applied, non-skinning, non-drying type.
- D. Underlayment: Self-adhering polymer modified asphalt sheet complying with ASTM D1970/D1970M, with strippable release film and top surface of woven polypropylene sheet.
 - 1. Sheet Thickness: 40 mils, 0.040 inch (1.02 mm), minimum.
 - 2. Self Sealability: Nail sealability in accordance with ASTM D1970/D1970M.
 - 3. Low Temperature Flexibility: Comply with ASTM D1970/D1970M.
 - 4. Water Vapor Permeance: 0.1 perm (5.72 ng/Pa s sq m), maximum, when tested in accordance with ASTM E96/E96M using Desiccant Method (Method A).
 - 5. Functional Temperature Range: Minus 45 degrees F (Minus 42.8 degrees C) to 250 degrees F (121 degrees C).
 - 6. Products:
 - a. Certainteed Roofing; WinterGuard HT - High Temperature Waterproofing Underlayment: www.certainteed.com/#sle.
 - b. Henry Company; Blueskin PE200HT: www.henry.com/#sle.
 - c. Polyglass USA, Inc; Polystick MTS Self-Adhered High Temperature Roof Underlayment: www.polyglass.us/#sle.
 - d. Grace Ice and Water Shield HT.

PART 3 EXECUTION

3.01 PREPARATION

- A. Coordinate roofing work with provisions for roof drainage, flashing, trim, penetrations, and other adjoining work to ensure that completed roof will be free of leaks.

- B. Separate dissimilar metals by applying a bituminous coating, self-adhering rubberized asphalt sheet, or other permanent method approved by metal roof panel manufacturer.
- C. At locations where metal will be in contact with wood or other absorbent material subject to wetting, seal joints with sealing compound and apply one coat of heavy-bodied bituminous paint.

3.02 INSTALLATION

- A. Overall: Install roofing system in accordance with approved shop drawings and metal roof panel manufacturer's instructions and recommendations, as applicable to specific project conditions; securely anchor components of roofing system in place allowing for thermal and structural movement.
 - 1. Install roofing system with concealed clips and fasteners, except as otherwise recommended by manufacturer for specific circumstances.
 - 2. Minimize field cutting of panels. Where field cutting is required, use methods that will not distort panel profiles. Use of torches for field cutting is prohibited.
- B. Accessories: Install necessary components that are required for complete roofing assembly, including flashings, gutters, downspouts, trim, moldings, closure strips, preformed crickets, caps, equipment curbs, rib closures, ridge closures, and similar roof accessory items.
- C. Roof Panels: Install metal roof panels in accordance with manufacturer's installation instructions, minimizing transverse joints except at junction with penetrations.

3.03 CLEANING

- A. Clean exposed sheet metal work at completion of installation. Remove grease and oil films, excess joint sealer, handling marks, and debris from installation, leaving the work clean and unmarked, free from dents, creases, waves, scratch marks, or other damage to the finish.

END OF SECTION

**SECTION 07 42 13
METAL PANELS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Manufactured metal panels for exterior wall panels, with related flashings and accessory components.

1.02 RELATED REQUIREMENTS

- A. Section 07 21 00 - Thermal Insulation.
- B. Section 07 27 00 - Air Barriers: Air barrier under wall panels.
- C. Section 07 62 00 - Sheet Metal Flashing and Trim: Metal flashing.
- D. Section 07 92 00 - Joint Sealants: Sealants and joint backing accessories.

1.03 REFERENCE STANDARDS

- A. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix); 2022.
- B. AAMA 609 & 610 - Cleaning and Maintenance Guide for Architecturally Finished Aluminum; 2025.
- C. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures; Most Recent Edition Cited by Referring Code or Reference Standard.
- D. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2025.
- E. ASTM A792/A792M - Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process; 2025.
- F. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2021a.
- G. ASTM C665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing; 2024.
- H. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2024.
- I. NFPA 285 - Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Wall Assemblies Containing Combustible Components; 2025.

1.04 SUBMITTALS

- A. Product Data - Wall System: Manufacturer's data sheets on each product to be used, including:
 - 1. Physical characteristics of components shown on shop drawings.
 - a. Construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel and accessory.
 - 2. Storage and handling requirements and recommendations.
 - 3. Installation instructions and recommendations.
- B. Sustainable Design Submittals:
 - 1. For recycled content, indicating postconsumer and preconsumer recycled content and cost.
- C. Shop Drawings: Indicate dimensions, layout, joints, construction details, support clips, and methods of anchorage.

1. Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.
 2. Include transition and termination details specific to this Project, including parapets, opening surrounds, and at-grade conditions.
- D. Samples for Verification: For each type of exposed finish, prepared on Samples of size indicated below:
1. Metal Panels: 12 inches by 12 inches.
- E. Qualification Data:
1. For professional engineer's experience with providing delegated-design engineering services of the kind indicated, including documentation that engineer is licensed in the State of California.
 2. For installer's experience in installing products specified in this section.
- F. Maintenance Data: For metal panels to include in maintenance manuals.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Protect panels from accelerated weathering by removing or venting sheet plastic shipping wrap.
- B. Deliver components, metal panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.
- C. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.
- D. Store prefinished material off the ground and protected from weather; prevent twisting, bending, or abrasion; provide ventilation; slope metal sheets to ensure proper drainage.
- E. Prevent contact with materials that may cause discoloration or staining of products.
- F. Retain strippable protective covering on metal panels during installation.

1.07 FIELD CONDITIONS

- A. Do not install wall panels when air temperature or relative humidity are outside manufacturer's limits.

1.08 COORDINATION

- A. Coordinate wall panel subframing support with cold-formed metal framing, exterior gypsum sheathing, and furring for complete structural support to meet performance criteria indicated.
- B. Coordinate metal panel installation with rain drainage work, flashing, trim, construction of soffits, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.09 WARRANTY

- A. Finish Warranty: Provide 20-year manufacturer warranty against excessive degradation of exterior finish. Complete forms in Owner's name and register with warrantor.
- B. Special Warranty: Provide 5-year warranty covering water tightness and integrity of seals of metal wall panels. Complete forms in Owner's name and register with warrantor.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 10 percent.

- B. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E1592:
 - 1. Wind Loads: As indicated on Drawings.
 - 2. Other Design Loads: As indicated on Drawings.
- C. Air Infiltration: Air leakage of not more than 0.06 cfm/sq. ft. when tested according to ASTM E283 at the following test-pressure difference:
 - 1. Test-Pressure Difference: 1.57 lbf/sq. ft.
- D. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E331 at the following test-pressure difference:
 - 1. Test-Pressure Difference: 2.86 lbf/sq. ft.
- E. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - 1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.
- F. Fire-Resistance Ratings Where Indicated on Drawings: Comply with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

2.02 MANUFACTURERS

- A. Metal Wall Panels - Match roof panels.

2.03 METAL WALL PANEL SYSTEM

- A. Wall Panel System: Factory fabricated prefinished metal panel system, site assembled.
 - 1. Provide exterior wall panels.
 - 2. Design and size components to support assembly dead loads, and to withstand live loads caused by positive and negative wind pressure acting normal to plane of wall.
 - 3. Maximum Allowable Deflection of Panel: $L/60$ for length(L) of span.
 - 4. Movement: Accommodate movement within system without damage to components or deterioration of seals, movement between system and perimeter components when subject to seasonal temperature cycling; dynamic loading and release of loads; and deflection of structural support framing.
 - 5. Fabrication: Formed true to shape, accurate in size, square, and free from distortion or defects; pieces of longest practical lengths.
 - 6. Corners: Factory-fabricated in one continuous piece with minimum 3/4-inch returns.
 - 7. Provide continuity of weather barrier seal at building enclosure elements in accordance with requirements; see Section 07 25 00.

2.04 MISCELLANEOUS MATERIALS

- A. Miscellaneous Metal Subframing and Furring: ASTM C645, cold-formed, metallic-coated steel sheet, ASTM A653/A653M, G90 coating designation or ASTM A792/A792M, Class AZ50 aluminum-zinc-alloy coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal panel system.
 - 1. Coordinate subframing with cold-formed metal framing, exterior gypsum sheathing, and furring for complete structural support and to meet performance criteria indicated.
 - 2. At perforated panel installations, finish miscellaneous subframing and furring to match metal panels.
- B. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets,

fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.

1. Closures: Provide closures at eaves and rakes, fabricated of same metal as metal panels.
 2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
 3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- thick, flexible closure strips; cut or premolded to match metal panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.
- C. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, bases, drips, sills, jambs, corners, endwalls, framed openings, rakes, fasciae, parapet caps, soffits, reveals, and fillers. Finish flashing and trim with same finish system as adjacent metal panels.
- D. Panel Fasteners: Self-tapping screws designed to withstand design loads. Provide exposed fasteners with heads. Provide EPDM or PVC sealing washers for exposed fasteners.
- E. Panel Sealants: Provide sealant type recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.
1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.
 2. Joint Sealant: ASTM C920; elastomeric polyurethane or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended in writing by metal panel manufacturer.
 3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C1311.

2.05 FABRICATION

- A. Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.
- B. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.
- C. Fabricate metal panel joints with factory-installed captive gaskets or separator strips that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.
- D. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.
1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
 2. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
 3. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
 4. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate sealant and to comply with SMACNA standards.
 5. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.

6. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal panel manufacturer.
7. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal wall panel manufacturer for application but not less than thickness of metal being secured.

2.06 FINISHES

- A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- C. For panels where both sides are exposed to view, such as rooftop equipment screens, finish both sides of panel.
- D. Fluoropolymer Coil Coating System: Polyvinylidene fluoride (PVDF) multi-coat superior performing organic coatings system complying with AAMA 2605, including at least 70 percent PVDF resin, and at least 80 percent of coil coated metal surfaces having minimum total dry film thickness (DFT) of 0.9 mil, 0.0009 inch (0.023 mm); custom color and gloss as selected by Architect.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal panel supports, and other conditions affecting performance of the Work.
 1. Examine wall framing to verify that girts, angles, channels, studs, and other structural panel support members and anchorage have been installed within alignment tolerances required by metal wall panel manufacturer.
 2. Examine wall sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal wall panel manufacturer.
 - a. Verify that air- or water-resistive barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.
- B. Examine roughing-in for components and systems penetrating metal panels to verify actual locations of penetrations relative to seam locations of metal panels before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages according to performance criteria indicated, ASTM C754, and metal panel manufacturer's written recommendations.
 1. Provide galvanic isolation between furring assembly and metal panels and other dissimilar materials.
 2. Mechanically fasten furring assembly to framing or concrete. Do not fasten furring assembly to gypsum sheathing.
 3. Install furring assembly so that it is concealed from view.
 4. Wire tie or clip soffit framing furring channels to supports, as required to comply with requirements for assemblies indicated.

3.03 INSTALLATION

- A. Install metal panels according to manufacturer's written instructions in orientation, sizes, and locations indicated. Install panels perpendicular to supports unless otherwise indicated. Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.
 - 1. Shim or otherwise plumb substrates receiving metal panels.
 - 2. Flash and seal metal panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until air- or water-resistive barriers and flashings that will be concealed by metal panels are installed.
 - 3. Install screw fasteners in predrilled holes.
 - 4. Locate and space fastenings in uniform vertical and horizontal alignment.
 - 5. Install flashing and trim as metal panel work proceeds.
 - 6. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
 - 7. Align bottoms of metal panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.
- B. Fasteners:
 - 1. Steel Panels: Use stainless steel fasteners for surfaces exposed to the exterior; use galvanized-steel fasteners for surfaces exposed to the interior.
 - 2. Aluminum Panels: Use aluminum or stainless steel fasteners for surfaces exposed to the exterior; use aluminum or galvanized-steel fasteners for surfaces exposed to the interior.
- C. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by metal panel manufacturer.
- D. Watertight Installation:
 - 1. Apply a continuous ribbon of sealant or tape to seal lapped joints of metal panels, using sealant or tape as recommend by manufacturer on side laps of nesting-type panels; and elsewhere as needed to make panels watertight.
 - 2. Provide sealant or tape between panels and protruding equipment, vents, and accessories.
 - 3. At panel splices, nest panels with minimum 6-inch end lap, sealed with sealant and fastened together by interlocking clamping plates.
- E. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.
 - 1. Install components required for a complete metal panel system including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items. Provide types indicated by metal wall panel manufacturer; or, if not indicated, provide types recommended by metal panel manufacturer.
- F. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that are permanently watertight.
 - 1. Install exposed flashing and trim that is without buckling and tool marks, and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and achieve waterproof performance.
 - 2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).

3.04 CLEANING AND PROTECTION

- A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.
- B. After metal panel installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.
- C. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION

SECTION 07 62 00
SHEET METAL FLASHING AND TRIM

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Fabricated sheet metal items, including flashings, counterflashings, gutters, and downspouts.
- B. Sealants for joints within sheet metal fabrications.

1.02 REFERENCE STANDARDS

- A. AAMA 2604 - Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix); 2022.
- B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2025.
- C. ASTM A666/A666M - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2024.
- D. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2021a.
- E. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; 2018.
- F. SMACNA (ASMM) - Architectural Sheet Metal Manual; 2012.

1.03 SUBMITTALS

- A. Shop Drawings: Indicate material profile, jointing pattern, jointing details, fastening methods, flashings, terminations, and installation details.

1.04 QUALITY ASSURANCE

- A. Perform work in accordance with SMACNA (ASMM) requirements and standard details, except as otherwise indicated.

PART 2 PRODUCTS

2.01 SHEET MATERIALS

- A. Galvanized Steel: ASTM A653/A653M, with G90/Z275 zinc coating; minimum 24-gauge, 0.0239-inch (0.61 mm) thick base metal.
- B. Pre-Finished Aluminum: ASTM B209/B209M, 3005 alloy, H12 or H14 temper; 18 gauge, 0.040 inch (1.02 mm) thick; plain finish shop pre-coated with fluoropolymer coating.
 - 1. Fluoropolymer Coating: High performance organic powder coating, AAMA 2604; multiple coat, thermally cured fluoropolymer finish system.
- C. Stainless Steel: ASTM A666/A666M, Type 304 alloy, soft temper, 28 gauge, 0.0156 inch (0.40 mm) thick; smooth No. 4 - Brushed finish.

2.02 FABRICATION

- A. Form sections true to shape, accurate in size, square, and free from distortion or defects.
- B. Form pieces in longest possible lengths.
- C. Hem exposed edges on underside 1/2 inch (13 mm); miter and seam corners.
- D. Form material with flat lock seams, except where otherwise indicated; at moving joints, use sealed lapped, bayonet-type or interlocking hooked seams.
- E. Fabricate corners from one piece with minimum 18-inch (450 mm) long legs; seam for rigidity, seal with sealant.
- F. Fabricate flashings to allow toe to extend 2 inches (50 mm) over roofing . Return and brake edges.

2.03 GUTTERS AND DOWNSPOUTS

- A. Gutters: SMACNA (ASMM) Rectangular profile.
- B. Downspouts: Rectangular profile.
- C. Gutters and Downspouts: Size indicated.
- D. Gutter and Downspout Material: Pre-Finished aluminum.
- E. Accessories: Profiled to suit gutters and downspouts.
 - 1. Anchorage Devices: In accordance with SMACNA (ASMM) requirements.
 - 2. Gutter Supports: Brackets.
 - 3. Downspout Supports: Straps.
- F. Seal metal joints.

2.04 ACCESSORIES

- A. Fasteners: Aluminum or Galvanized steel, with soft neoprene washers.
- B. Primer Type: Zinc chromate.
- C. Concealed Sealants: Non-curing butyl sealant.
- D. Exposed Sealants: ASTM C920; elastomeric sealant, with minimum movement capability as recommended by manufacturer for substrates to be sealed; color to match adjacent material.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify roof openings, curbs, pipes, sleeves, ducts, and vents through roof are solidly set, reglets in place, and nailing strips located.
- B. Verify roofing termination and base flashings are in place, sealed, and secure.

3.02 INSTALLATION

- A. Secure flashings in place using concealed fasteners, and use exposed fasteners only where permitted..
- B. Apply plastic cement compound between metal flashings and felt flashings.
- C. Fit flashings tight in place; make corners square, surfaces true and straight in planes, and lines accurate to profiles.
- D. Seal metal joints watertight.
- E. Secure gutters and downspouts in place with concealed fasteners.
- F. Slope gutters 1/4 inch per 10 feet (2.1 mm per m), minimum.

END OF SECTION

**SECTION 07 72 00
ROOF ACCESSORIES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Ridge vents.
- B. Snow guards.

1.02 SUBMITTALS

- A. Product Data: Manufacturer's data sheets on each product to be used.
 - 1. Preparation instructions and recommendations.
 - 2. Storage and handling requirements and recommendations.
 - 3. Installation methods.
 - 4. Maintenance requirements.
- B. Shop Drawings: Submit detailed layout developed for this project and provide dimensioned location and number for each type of roof accessory.

1.03 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Store products under cover and elevated above grade.

PART 2 PRODUCTS

2.01 ROOF HATCHES AND VENTS

- A. Ridge Vents: Factory fabricated, formed panels with integral attachment flanges and snap-on cover.
 - 1. Perforated Screen: 0.050-inch (1.27 mm) thick aluminum.
 - 2. Brackets: Manufacturer's standard 20 gauge, 0.0359 inch (0.91 mm).
 - 3. Finish: Manufacturer's standard polyvinylidene fluoride (PVDF) coating.
 - 4. Finish Color: To be selected by Architect from manufacturer's standard range.
 - 5. Products:
 - a. Atlas Roofing Corporation; Techni-Flo RV Engineered Ridge Vent, All Weather www.atlasroofing.com/#sle.
 - b. Certainteed Roofing: www.certainteed.com/#sle.
 - c. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 SNOW GUARDS

- A. Roof Membrane Fence Type Snow Guards: Base plate attached on top of EPDM, TPO, or PVC roof membrane and anchored to roof deck with mounting bracket that supports flat-faced bar or single tube snow guard.
 - 1. Base Plate: Stainless steel plate with holes for mounting with anchor bolts through membrane to roof deck.
 - 2. Bracket: Aluminum mounting bracket bolted to base plate.

PART 3 EXECUTION

3.01 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using methods recommended by manufacturer for achieving acceptable results for applicable substrate under project conditions.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions, in manner that maintains roofing system weather-tight integrity.

3.03 CLEANING

- A. Clean installed work to like-new condition.

3.04 PROTECTION

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Date of Substantial Completion.

END OF SECTION

SECTION 07 84 00 FIRESTOPPING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Firestopping systems.
- B. Firestopping of joints and penetrations in fire-resistance-rated and smoke-resistant assemblies, whether indicated on drawings or not, and other openings indicated.

1.02 REFERENCE STANDARDS

- A. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials; 2024.
- B. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems; 2024.
- C. ASTM E1966 - Standard Test Method for Fire-Resistive Joint Systems; 2024.
- D. ASTM E2174 - Standard Practice for On-Site Inspection of Installed Firestop Systems; 2024.
- E. ASTM E2393 - Standard Practice for On-Site Inspection of Installed Fire Resistive Joint Systems and Perimeter Fire Barriers; 2024.
- F. ASTM E2307 - Standard Test Method for Determining Fire Resistance of Perimeter Fire Barriers Using Intermediate-Scale, Multi-Story Test Apparatus; 2025.
- G. ASTM E2837 - Standard Test Method for Determining the Fire Resistance of Continuity Head-of-Wall Joint Systems Installed between Rated Wall Assemblies and Nonrated Horizontal Assemblies; 2023a, with Editorial Revision (2024).
- H. ITS (DIR) - Directory of Listed Products; Current Edition.
- I. FM 4991 - Approval Standard of Firestop Contractors; 2013.
- J. FM (AG) - FM Approval Guide; Current Edition.
- K. SCAQMD 1168 - Adhesive and Sealant Applications; 1989, with Amendment (2022).
- L. UL 1479 - Standard for Fire Tests of Penetration Firestops; Current Edition, Including All Revisions.
- M. UL 2079 - Standard for Tests for Fire Resistance of Building Joint Systems; Current Edition, Including All Revisions.
- N. UL (DIR) - Online Certifications Directory; Current Edition.
- O. UL (FRD) - Fire Resistance Directory; Current Edition.

1.03 SUBMITTALS

- A. See Section 01 33 00 for submittal procedures.
- B. Schedule of Firestopping: List each type of penetration, fire rating of the penetrated assembly, and firestopping test or design number.
- C. Product Data: Provide data on product characteristics, performance ratings, and limitations.
- D. Sustainable Design Submittal: Submit VOC content documentation for nonpreformed materials.
- E. Installer's qualification statement.

1.04 QUALITY ASSURANCE

- A. Fire Testing: Provide firestopping assemblies of designs that provide the scheduled fire ratings when tested in accordance with methods indicated.
 - 1. Listing in UL (FRD), FM (AG), or ITS (DIR) will be considered as constituting an acceptable test report.

2. Valid evaluation report published by ICC Evaluation Service, Inc. (ICC-ES) at www.icc-es.org will be considered as constituting an acceptable test report.
 3. Submission of actual test reports is required for assemblies for which none of the above substantiation exists.
- B. Installer Qualifications: Company specializing in performing the work of this section and:
1. Approved by Factory Mutual Research Corporation under FM 4991, or meeting any two of the following requirements:
 2. Verification of minimum three years documented experience installing work of this type.
 3. Verification of at least five satisfactorily completed projects of comparable size and type.
 4. Licensed by local authorities having jurisdiction (AHJ).

1.05 FIELD CONDITIONS

- A. Comply with firestopping manufacturer's recommendations for temperature and conditions during and after installation; maintain minimum temperature before, during, and for three days after installation of materials.
- B. Provide ventilation in areas where solvent-cured materials are being installed.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Firestopping Manufacturers:
1. 3M Fire Protection Products: www.3m.com/firestop/#sle.
 2. A/D Fire Protection Systems Inc: www.adfire.com/#sle.
 3. Grabber Construction Products, Inc: www.grabberman.com/#sle.
 4. Hilti, Inc: www.hilti.com/#sle.
 5. HoldRite, a Brand of Reliance Worldwide Corporation: www.holdrite.com/#sle.
 6. Passive Fire Protection Partners: www.firestop.com/#sle.
 7. RectorSeal, a CSW Industrials Company: www.rectorseal.com/firestop-solutions/#sle.
 8. Specified Technologies Inc: www.stifirestop.com/#sle.
 9. Tremco Commercial Sealants & Waterproofing: www.tremcosealants.com/#sle.
 10. Substitutions: See Section 01 62 10.

2.02 MATERIALS

- A. Firestopping Materials: Any materials meeting requirements.
- B. Volatile Organic Compound (VOC) Content: Provide products having VOC content lower than that required by SCAQMD 1168.
- C. Primers, Sleeves, Forms, Insulation, Packing, Stuffing, and Accessories: Provide type of materials as required for tested firestopping assembly.
- D. Fire Ratings: Refer to drawings for required systems and ratings.

2.03 FIRESTOPPING ASSEMBLY REQUIREMENTS

- A. Perimeter Fire Containment Firestopping: Use system that has been tested according to ASTM E2307 to have fire resistance F Rating equal to required fire rating of floor assembly.
- B. Head-of-Wall (HW) Joint System Firestopping at Joints Between Fire-Rated Wall Assemblies and Non-Rated Horizontal Assemblies: Use system that has been tested according to ASTM E2837 to have fire resistance F Rating equal to required fire rating of wall assembly.
- C. Floor-to-Floor (FF), Floor-to-Wall (FW), Head-of-Wall (HW), and Wall-to-Wall (WW) Joints, Except Perimeter, Where Both Are Fire-Rated: Use system that has been tested according to ASTM E1966 or UL 2079 to have fire resistance F Rating equal to required fire rating of the assembly in which the joint occurs.
1. Listing by FM (AG), ITS (DIR), or UL (DIR) in their certification directories will be considered evidence of successful testing.

- D. Through Penetration Firestopping: Use system that has been tested according to ASTM E814 to have fire resistance F Rating equal to required fire rating of penetrated assembly.
 - 1. Listing by FM (AG), ITS (DIR), or UL (DIR) in their certification directories will be considered evidence of successful testing.

2.04 FIRESTOPPING SYSTEMS

- A. Firestopping: Any material meeting requirements.
 - 1. Fire Ratings: Use system that is listed by FM (AG), ITS (DIR), or UL (FRD) and tested in accordance with ASTM E814, ASTM E119, or UL 1479 with F Rating equal to fire rating of penetrated assembly and minimum T Rating Equal to F Rating and in compliance with other specified requirements.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify openings are ready to receive the work of this section.

3.02 PREPARATION

- A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other materials that could adversely affect bond of firestopping material.
- B. Remove incompatible materials that could adversely affect bond.
- C. Install backing materials to prevent liquid material from leakage.

3.03 INSTALLATION

- A. Install materials in manner described in fire test report and in accordance with manufacturer's instructions, completely closing openings.
- B. Do not cover installed firestopping until inspected by Owner's Independent Testing Agency.
- C. Do not cover installed firestopping until inspected by authorities having jurisdiction.
- D. Install labeling required by code.

3.04 FIELD QUALITY CONTROL

- A. Independent Testing Agency: Inspection agency employed and paid by Owner, will examine penetration firestopping in accordance with ASTM E2174 and ASTM E2393.
- B. Repair or replace penetration firestopping and joints at locations where inspection results indicate firestopping or joints do not meet specified requirements.

3.05 CLEANING

- A. Clean adjacent surfaces of firestopping materials.

3.06 PROTECTION

- A. Protect adjacent surfaces from damage by material installation.

END OF SECTION

**SECTION 07 92 00
JOINT SEALANTS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Nonsag gunnable joint sealants.
- B. Self-leveling pourable joint sealants.
- C. Joint backings and accessories.

1.02 RELATED REQUIREMENTS

- A. Section 09 21 16 - Gypsum Board Assemblies: Sealing acoustical and sound-rated walls and ceilings.

1.03 REFERENCE STANDARDS

- A. ASTM C834 - Standard Specification for Latex Sealants; 2017 (Reapproved 2023).
- B. ASTM C919 - Standard Practice for Use of Sealants in Acoustical Applications; 2024.
- C. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; 2018.
- D. ASTM C1193 - Standard Guide for Use of Joint Sealants; 2025.
- E. ASTM C1248 - Standard Test Method for Staining of Porous Substrate by Joint Sealants; 2022.
- F. ASTM C1330 - Standard Specification for Cylindrical Sealant Backing for Use with Cold Liquid-Applied Sealants; 2023.
- G. ASTM D2240 - Standard Test Method for Rubber Property--Durometer Hardness; 2015 (Reapproved 2021).
- H. SCAQMD 1168 - Adhesive and Sealant Applications; 1989, with Amendment (2022).

1.04 SUBMITTALS

- A. See Section 01 33 00 for submittal procedures.
- B. Product Data: Submit manufacturer's technical datasheets for each product to be used; include the following:
 - 1. Physical characteristics, including movement capability, VOC content, hardness, cure time, and color availability.
 - 2. List of backing materials approved for use with the specific product.
 - 3. Substrates that product is known to satisfactorily adhere to and with which it is compatible.
 - 4. Substrates the product should not be used on.
 - 5. Substrates for which use of primer is required.
 - 6. Sample product warranty.
 - 7. Certification by manufacturer indicating that product complies with specification requirements.
- C. Product Data for Accessory Products: Submit manufacturer's technical data sheet for each product to be used, including physical characteristics, installation instructions, and recommended tools.
- D. Field Quality Control Plan: Submit at least two weeks prior to start of installation.
- E. Field Quality Control Log: Submit filled-out log for each length or instance of sealant installed, within 10 days after completion of inspections/tests; include bagged test samples and photographic records, if any.
- F. Installer's qualification statement.
- G. Executed warranty.

1.05 QUALITY ASSURANCE

- A. Maintain one copy of each referenced document covering installation requirements on site.
- B. Installer Qualifications: Company specializing in performing the work of this section and with at least three years of experience.
- C. Testing Agency Qualifications: Independent firm specializing in performing testing and inspections of the type specified in this section.
- D. Field Quality Control Plan:
 - 1. Field testing agency's qualifications.
 - 2. Field Quality Control Log Form: Show same data fields as on Preinstallation Field Adhesion Test Log, with known information filled out and lines for multiple tests per sealant/substrate combinations; include visual inspection and specified field testing; allow for possibility that more tests than minimum specified may be necessary.

1.06 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
- B. Manufacturer Warranty: Provide 2-year manufacturer warranty for installed sealants and accessories that fail to achieve a watertight seal, exhibit loss of adhesion or cohesion, or do not cure. Complete forms in Owner's name and register with manufacturer.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Nonsag Sealants:
 - 1. Dow: www.dow.com/#sle.
 - 2. Pecora Corporation: www.pecora.com/#sle.
 - 3. Sika Corporation: www.usa.sika.com/#sle.
 - 4. Tremco Commercial Sealants & Waterproofing: www.tremcosealants.com/#sle.

2.02 JOINT SEALANT APPLICATIONS

- A. Scope:
 - 1. Exterior Joints: Seal open joints, whether or not the joint is indicated on drawings, unless specifically indicated not to be sealed. Exterior joints to be sealed include, but are not limited to:
 - a. Wall expansion and control joints.
 - b. Joints between door, window, and other frames and adjacent construction.
 - c. Joints between different exposed materials.
 - d. Other joints indicated below.
 - 2. Interior Joints: Do not seal interior joints unless specifically indicated to be sealed. Interior joints to be sealed include, but are not limited to, the following items.
 - a. Joints between door, window, and other frames and adjacent construction.
 - b. In sound-rated wall and ceiling assemblies, gaps at electrical outlets, wiring devices, piping, and other openings; between wall/ceiling and other construction; and other flanking sound paths.
 - c. Other joints indicated below.
 - 3. Do not seal the following types of joints:
 - a. Joints indicated to be treated with manufactured expansion joint cover, or some other type of sealing device.
 - b. Joints where sealant is specified to be provided by manufacturer of product to be sealed.
 - c. Joints where installation of sealant is specified in another section.
 - d. Joints between suspended panel ceilings/grid and walls.
- B. Exterior Joints: Use nonsag nonstaining silicone sealant, unless otherwise indicated.
 - 1. Lap Joints in Sheet Metal Fabrications: Butyl rubber, noncuring.

2. Lap Joints between Manufactured Metal Panels: Butyl rubber, noncuring.
 3. Control and Expansion Joints in Concrete Paving: Self-leveling polyurethane traffic-grade sealant.
- C. Interior Joints: Use nonsag polyurethane sealant, unless otherwise indicated.
1. Wall and Ceiling Joints in Nonwet Areas: Acrylic emulsion latex sealant.
 2. Wall and Ceiling Joints in Wet Areas: Nonsag polyurethane sealant for continuous liquid immersion.
 3. Floor Joints in Wet Areas: Nonsag polyurethane non-traffic-grade sealant suitable for continuous liquid immersion.
 4. Joints between Tile in Wet Areas and Floors, Walls, and Ceilings: Mildew-resistant silicone sealant; white.
 5. In Sound-Rated Assemblies: Acrylic emulsion latex sealant.
 6. Narrow Control Joints in Interior Concrete Slabs: Self-leveling epoxy sealant.
 7. Other Floor Joints: Self-leveling polyurethane traffic-grade sealant.
- D. Interior Wet Areas: Restrooms; fixtures in wet areas include plumbing fixtures, countertops, cabinets, and other similar items.
- E. Sound-Rated Assemblies: Walls and ceilings identified as STC-rated, sound-rated, or acoustical.

2.03 JOINT SEALANTS - GENERAL

- A. Sealants and Primers: Provide products having lower volatile organic compound (VOC) content than indicated in SCAQMD 1168.
- B. Colors: As indicated on drawings or match adjacent surface.

2.04 NONSAG JOINT SEALANTS

- A. Type ____ - Nonstaining Silicone Sealant: ASTM C920, Grade NS, Uses M and A; not expected to withstand continuous water immersion or traffic.
1. Movement Capability: Plus and minus ____ percent, minimum.
 2. Nonstaining to Porous Stone: Nonstaining to light-colored natural stone when tested in accordance with ASTM C1248.
 3. Dirt Pick-Up: Reduced dirt pick-up compared to other silicone sealants.
- B. Silicone Sealant: ASTM C920, Grade NS, Uses M and A; not expected to withstand continuous water immersion or traffic.
1. Movement Capability: Plus and minus 25 percent, minimum.
 2. Color: Match adjacent finished surfaces.
 3. Products:
 - a. Dow; DOWSIL 999-A Building and Glazing Sealant: www.dow.com/#sle.
 - b. Pecora Corporation; Pecora 860: www.pecora.com/#sle.
 - c. Sika Corporation; Sikasil GP: www.usa.sika.com/#sle.
- C. Mildew-Resistant Silicone Sealant: ASTM C920, Grade NS, Uses M and A; single component, mildew resistant; not expected to withstand continuous water immersion or traffic.
1. Color: White.
 2. Products:
 - a. Pecora Corporation; Pecora 898 NST (Non-Staining Technology): www.pecora.com/#sle.
 - b. Sika Corporation; Sikasil GP: www.usa.sika.com/#sle.
- D. Acrylic Emulsion Latex: Water-based; ASTM C834, single component, nonstaining, nonbleeding, nonsagging; not intended for exterior use.
1. Color: Standard colors matching finished surfaces, Type OP (opaque).
 2. Products:
 - a. Pecora Corporation; AC-20 +Silicone: www.pecora.com/#sle.

- b. Tremco Commercial Sealants & Waterproofing; Tremflex 834:
www.tremcosealants.com/#sle.
- E. Type ____ - Noncuring Butyl Sealant: Solvent-based, single component, nonsag, nonskinning, nonhardening, nonbleeding; nonvapor permeable; intended for fully concealed applications.

2.05 SELF-LEVELING JOINT SEALANTS

- A. Type ____ - Self-Leveling Polyurethane Sealant: ASTM C920, Grade P, Uses M and A; single or multicomponent; explicitly approved by manufacturer for traffic exposure; not expected to withstand continuous water immersion .
 - 1. Movement Capability: Plus and minus 25 percent, minimum.
- B. Type ____ - Self-Leveling Polyurethane Sealant for Continuous Water Immersion: Polyurethane; ASTM C920, Grade P, Uses M and A; single component; explicitly approved by manufacturer for traffic exposure and continuous water immersion.
- C. Type ____ - Semi-Rigid Self-Leveling Epoxy Joint Filler: Epoxy or epoxy/polyurethane copolymer; intended for filling cracks and control joints not subject to significant movement; rigid enough to support concrete edges under traffic.
 - 1. Composition: Multicomponent, 100 percent solids by weight.
 - 2. Durometer Hardness: Minimum of 85 for Type A or 35 for Type D, after seven days when tested in accordance with ASTM D2240.
 - 3. Joint Width, Minimum: 1/8 inch (3 mm).

2.06 ACCESSORIES

- A. Backer Rod: Cylindrical cellular foam rod with surface that sealant will not adhere to, compatible with specific sealant used, and recommended by backing and sealant manufacturers for specific application.
 - 1. Type for Joints Not Subject to Pedestrian or Vehicular Traffic: ASTM C1330; Type O - Open Cell Polyurethane.
 - 2. Type for Joints Subject to Pedestrian or Vehicular Traffic: ASTM C1330; Type B - Bi-Cellular Polyethylene.
 - 3. Open Cell: 40 to 50 percent larger in diameter than joint width.
 - 4. Closed Cell and Bi-Cellular: 25 to 33 percent larger in diameter than joint width.
- B. Backing Tape: Self-adhesive polyethylene tape with surface that sealant will not adhere to and recommended by tape and sealant manufacturers for specific application.
- C. Masking Tape: Self-adhesive, nonabsorbent, nonstaining, removable without adhesive residue, and compatible with surfaces adjacent to joints and sealants.
- D. Joint Cleaner: Noncorrosive and nonstaining type, type recommended by sealant manufacturer; compatible with joint forming materials.
- E. Primers: Type recommended by sealant manufacturer to suit application; nonstaining.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that joints are ready to receive work.
- B. Verify that backing materials are compatible with sealants.
- C. Verify that backer rods are of the correct size.

3.02 PREPARATION

- A. Remove loose materials and foreign matter that could impair adhesion of sealant.
- B. Clean joints, and prime as necessary, in accordance with manufacturer's instructions.
- C. Perform preparation in accordance with manufacturer's instructions and ASTM C1193.

- D. Mask elements and surfaces adjacent to joints from damage and disfigurement due to sealant work; be aware that sealant drips and smears may not be completely removable.

3.03 INSTALLATION

- A. Install this work in accordance with sealant manufacturer's requirements for preparation of surfaces and material installation instructions.
- B. Provide joint sealant installations complying with ASTM C1193.
- C. Install acoustical sealant application work in accordance with ASTM C919.
- D. Measure joint dimensions and size joint backers to achieve width-to-depth ratio, neck dimension, and surface bond area as recommended by manufacturer, except where specific dimensions are indicated.
- E. Install bond breaker backing tape where backer rod cannot be used.
- F. Install sealant free of air pockets, foreign embedded matter, ridges, and sags, and without getting sealant on adjacent surfaces.
- G. Do not install sealant when ambient temperature is outside manufacturer's recommended temperature range, or will be outside that range during the entire curing period, unless manufacturer's approval is obtained and instructions are followed.
- H. Nonsag Sealants: Tool surface concave, unless otherwise indicated; remove masking tape immediately after tooling sealant surface.
- I. Concrete Floor Joint Filler: After full cure, shave joint filler flush with top of concrete slab.

3.04 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements for additional requirements.
- B. Perform field quality control inspection/testing as specified in PART 1 under QUALITY ASSURANCE article.
- C. Remove and replace failed portions of sealants using same materials and procedures as indicated for original installation.

END OF SECTION

**SECTION 07 95 13
EXPANSION JOINT COVER ASSEMBLIES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Expansion joint cover assemblies for floor, wall, ceiling, and roof surfaces.

1.02 RELATED REQUIREMENTS

- A. Section 09 21 16 - Gypsum Board Assemblies: Placement of expansion joint assemblies in gypsum board walls and ceilings.
- B. Section 09 51 00 - Acoustical Ceilings: Expansion joint assemblies in suspended ceiling grids.

1.03 REFERENCE STANDARDS

- A. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2021.
- B. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric); 2021.
- C. ASTM B308/B308M - Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles; 2020.

1.04 SUBMITTALS

- A. Product Data: Provide joint assembly profiles, profile dimensions, anchorage devices and available colors and finish.
- B. Shop Drawings: Indicate joint and splice locations, miters, layout of the work, affected adjacent construction and anchorage locations.
- C. Manufacturer's Installation Instructions: Indicate rough-in sizes and required tolerances for item placement.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Expansion Joint Cover Assemblies:
- B. Basis of Design: Construction Specialties, Inc. www.c-sgroup.com/#sle, assemblies as indicated on drawings, or provide equal products by one of the following:
 - 1. Balco, Inc: www.balcousa.com/#sle.
 - 2. Nystrom, Inc: www.nystrom.com/#sle.

2.02 EXPANSION JOINT COVER ASSEMBLY APPLICATIONS

- A. Interior Floor Joints Subject to Seismic Movement.
- B. Interior Wall/Ceiling Joints Subject to Seismic Movement.
- C. Exterior Wall Joints Subject to Seismic Movement.
- D. Exterior Roof Expansion Joint Covers.

2.03 EXPANSION JOINT COVER ASSEMBLIES

- A. Expansion Joint Cover Assemblies - General: Factory-fabricated and assembled; designed to completely fill joint openings, sealed to prevent passage of air, dust, water, smoke; suitable for traffic expected.
 - 1. Joint Dimensions and Configurations: As indicated on drawings.
 - 2. Joint Cover Sizes: Selected to suit joint width and configuration, based on manufacturer's published recommendations and limitations.
 - 3. Lengths: Provide covers in full lengths required; avoid splicing wherever possible.
 - 4. Anchors, Fasteners, and Fittings: Provided by cover manufacturer.

- B. Floor Joint Covers: Coordinate with indicated floor coverings.

2.04 MATERIALS

- A. Extruded Aluminum: ASTM B221 (ASTM B221M), 6063 alloy, T6 temper; or ASTM B308/B308M, 6061 alloy, T6 temper.
 - 1. Exposed Finish at Floors: Mill finish or natural anodized.
 - 2. Exposed Finish at Walls and Ceilings: Natural anodized.
- B. Resilient Seals:
 - 1. For Ceilings: Any resilient material, flush, pleated, or hollow gasket.
 - 2. For Pedestrian Traffic Applications: EPDM rubber, Neoprene, or Santoprene; no PVC; Shore A hardness of 40 to 50 Durometer.
- C. Backing Paint for Aluminum Components in Contact with Cementitious Materials: Asphaltic type.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install components and accessories in accordance with manufacturer's instructions.
- B. Align work plumb and level, flush with adjacent surfaces.
- C. Rigidly anchor to substrate to prevent misalignment.

END OF SECTION

**SECTION 08 11 13
HOLLOW METAL DOORS AND FRAMES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Non-fire-rated hollow metal doors and frames.
- B. Hollow metal frames for wood doors.
- C. Fire-rated hollow metal doors and frames.
- D. Thermally insulated hollow metal doors with frames.
- E. Hollow metal borrowed lites glazing frames.
- F. Accessories, including door window frames.

1.02 RELATED REQUIREMENTS

- A. Section 08 71 00 - Door Hardware.
- B. Section 08 80 00 - Glazing: Glass for doors and borrowed lites.
- C. Section 09 91 13 - Exterior Painting: Field painting.
- D. Section 09 91 23 - Interior Painting: Field painting.

1.03 ABBREVIATIONS AND ACRONYMS

- A. ANSI: American National Standards Institute.
- B. HMMA: Hollow Metal Manufacturers Association.
- C. NAAMM: National Association of Architectural Metal Manufacturers.
- D. NFPA: National Fire Protection Association.
- E. SDI: Steel Door Institute.
- F. UL: Underwriters Laboratories.

1.04 REFERENCE STANDARDS

- A. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.
- B. ANSI/SDI A250.4 - Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors, Frames and Frame Anchors; 2024.
- C. ANSI/SDI A250.6 - Recommended Practice for Hardware Reinforcing on Standard Steel Doors and Frames; 2024.
- D. ANSI/SDI A250.8 - Specifications for Standard Steel Doors and Frames (SDI-100); 2023.
- E. ANSI/SDI A250.10 - Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames; 2025.
- F. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2025.
- G. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Required Hardness, Solution Hardened, and Bake Hardenable; 2024.
- H. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength; 2023.
- I. BHMA A156.115 - Hardware Preparation in Steel Doors and Frames; 2016.
- J. ICC A117.1 - Accessible and Usable Buildings and Facilities; 2017.
- K. ITS (DIR) - Directory of Listed Products; Current Edition.

- L. NAAMM HMMA 830 - Hardware Selection for Hollow Metal Doors and Frames; 2002.
- M. NAAMM HMMA 831 - Hardware Locations for Hollow Metal Doors and Frames; 2024.
- N. NAAMM HMMA 840 - Guide Specifications for Receipt, Storage and Installation of Hollow Metal Doors and Frames; 2024.
- O. NAAMM HMMA 861 - Guide Specifications for Commercial Hollow Metal Doors and Frames; 2014.
- P. NFPA 80 - Standard for Fire Doors and Other Opening Protectives; 2025.
- Q. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies; 2022.
- R. SDI 117 - Manufacturing Tolerances for Standard Steel Doors and Frames; 2023.
- S. UL (DIR) - Online Certifications Directory; Current Edition.
- T. UL 10C - Standard for Positive Pressure Fire Tests of Door Assemblies; Current Edition, Including All Revisions.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Materials and details of design and construction, hardware locations, reinforcement type and locations, anchorage and fastening methods, and finishes; and one copy of referenced standards/guidelines.
- C. Shop Drawings: Details of each opening, showing elevations, glazing, frame profiles, and any indicated finish requirements.

1.06 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years experience.
- B. Manufacturer Qualifications: Provide hollow metal doors and frames from SDI Certified manufacturer: <https://steeldoor.org/sdi-certified/#sle>.
- C. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of experience.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Comply with NAAMM HMMA 840 or ANSI/SDI A250.8 (SDI-100) in accordance with specified requirements.
- B. Protect with resilient packaging; avoid humidity build-up under coverings; prevent corrosion and adverse effects on factory applied painted finish.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Hollow Metal Doors and Frames:
 - 1. Ceco Door, an Assa Abloy Group company: www.assaabloydss.com/#sle.
 - 2. Curries, an Assa Abloy Group company: www.assaabloydss.com/#sle.
 - 3. Mesker, dormakaba Group: www.meskeropeningsgroup.com/#sle.
 - 4. Republic Doors, an Allegion brand: www.republicdoor.com/#sle.
 - 5. Steelcraft, an Allegion brand: www.allegion.com/#sle.
- B. Basis-of-Design Product: In compliance with requirements, provide a product by one of the above manufacturers to match existing door: Steelcraft L Series.

2.02 PERFORMANCE REQUIREMENTS

- A. Requirements for Hollow Metal Doors and Frames:
 - 1. Steel Sheet: Comply with one or more of the following requirements; galvanized steel complying with ASTM A653/A653M, cold-rolled steel complying with ASTM

- A1008/A1008M, or hot-rolled pickled and oiled (HRPO) steel complying with ASTM A1011/A1011M, commercial steel (CS) Type B, for each.
2. Accessibility: Comply with ICC A117.1 and ADA Standards.
 3. Door Edge Profile: Manufacturers standard for application indicated.
 4. Typical Door Face Sheets: Flush.
 5. Hardware Preparations, Selections and Locations: Comply with NAAMM HMMA 830 and NAAMM HMMA 831 or BHMA A156.115 and ANSI/SDI A250.8 (SDI-100) in accordance with specified requirements.
- B. Combined Requirements: If a particular door and frame unit is indicated to comply with more than one type of requirement, comply with the specified requirements for each type; for instance, an exterior door that is also indicated as being sound-rated must comply with the requirements specified for exterior doors and for sound-rated doors; where two requirements conflict, comply with the most stringent.

2.03 HOLLOW METAL DOORS

- A. Door Finish: Factory primed and field finished.
- B. Exterior Doors: Thermally insulated.
1. Based on SDI Standards: ANSI/SDI A250.8 (SDI-100).
 - a. Level 3 - Extra Heavy-duty.
 - b. Physical Performance Level A, 1,000,000 cycles; in accordance with ANSI/SDI A250.4.
 - c. Model 1 - Full Flush.
 - d. Door Face Metal Thickness: 16 gauge, 0.053 inch (1.3 mm), minimum.
 2. Door Thickness: 1-3/4 inches (44.5 mm), nominal.
- C. Interior Doors, Non-Fire-Rated:
1. Based on SDI Standards: ANSI/SDI A250.8 (SDI-100).
 - a. Level 3 - Extra Heavy-duty.
 - b. Physical Performance Level A, 1,000,000 cycles; in accordance with ANSI/SDI A250.4.
 - c. Model 1 - Full Flush.
 - d. Door Face Metal Thickness: 16 gauge, 0.053 inch (1.3 mm), minimum.
 2. Door Thickness: 1-3/4 inches (44.5 mm), nominal.
- D. Fire-Rated Doors:
1. Based on SDI Standards: ANSI/SDI A250.8 (SDI-100).
 - a. Level 3 - Extra Heavy-duty.
 - b. Physical Performance Level A, 1,000,000 cycles; in accordance with ANSI/SDI A250.4.
 - c. Model 1 - Full Flush.
 - d. Door Face Metal Thickness: 16 gauge, 0.053 inch (1.3 mm), minimum.
 2. Fire Rating: As indicated on Door Schedule, tested in accordance with UL 10C and NFPA 252 ("positive pressure fire tests").
 3. Provide units listed and labeled by UL (DIR) or ITS (DIR).
 - a. Attach fire rating label to each fire rated unit.
 4. Door Core Material: Manufacturers standard honeycomb core material/construction in compliance with requirements.
 5. Door Edge Seam: Welded.
 6. Door Thickness: 1-3/4 inches (44.5 mm), nominal.

2.04 HOLLOW METAL FRAMES

- A. Comply with standards and/or custom guidelines as indicated for corresponding door in accordance with applicable door frame requirements.

- B. Frame Finish: Factory primed and field finished.
- C. Exterior Door Frames: Full profile/continuously welded type.
 - 1. Weatherstripping: Separate, see Section 08 71 00.
- D. Interior Door Frames, Non-Fire Rated: Knock-down type.
- E. Door Frames, Fire-Rated: Knock-down type
 - 1. Fire Rating: Same as door, labeled.
- F. Frames for Wood Doors: Comply with frame requirements in accordance with corresponding door.
- G. Borrowed Lites Glazing Frames: Construction and face dimensions to match door frames, and as indicated on drawings.

2.05 FINISHES

- A. Primer: Rust-inhibiting, complying with ANSI/SDI A250.10, door manufacturer's standard.

2.06 ACCESSORIES

- A. Door Window Frames: Door window frames with glazing securely fastened within door opening.
 - 1. Size: As indicated on drawings.
 - 2. Frame Material: 20 guage (1mm) cold rolled steel, .
 - 3. Metal Finish: Baked enamel; match existing color in building.
 - 4. Manufacturers:
 - a. Anemostat; LoPro.
- B. Glazing: As specified in Section 08 80 00, factory installed.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that opening sizes and tolerances are acceptable.
- C. Verify that finished walls are in plane to ensure proper door alignment.

3.02 INSTALLATION

- A. Install doors and frames in accordance with manufacturer's instructions and related requirements of specified door and frame standards or custom guidelines indicated.
- B. Install fire rated units in accordance with NFPA 80.
- C. Coordinate frame anchor placement with wall construction.
- D. Install door hardware as specified in Section 08 71 00.
 - 1. Comply with recommended practice for hardware placement of doors and frames in accordance with ANSI/SDI A250.6 or NAAMM HMMA 861.

3.03 TOLERANCES

- A. Clearances Between Door and Frame: Comply with related requirements of specified frame standards or custom guidelines indicated in accordance with SDI 117 or NAAMM HMMA 861.
- B. Maximum Diagonal Distortion: 1/16 inch (1.6 mm) measured with straight edge, corner to corner.

3.04 ADJUSTING

- A. Adjust for smooth and balanced door movement.

3.05 SCHEDULE

- A. Refer to Door and Window Schedules on the drawings.

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Palmer Courthouse Renovation & Expansion
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END OF SECTION

**SECTION 08 14 16
FLUSH WOOD DOORS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Flush wood doors; flush configuration; fire-rated and non-rated
- B. Accessories, including door window frames.

1.02 RELATED REQUIREMENTS

- A. Section 08 11 13 - Hollow Metal Doors and Frames.
- B. Section 08 71 00 - Door Hardware.
- C. Section 08 80 00 - Glazing.
- D. Section 09 91 23 - Interior Painting: Field finishing of doors.

1.03 REFERENCE STANDARDS

- A. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards, 2nd Edition; 2014, with Errata (2016).
- B. AWMAC/WI (NAAWS) - North American Architectural Woodwork Standards; 2021, with Errata.
- C. ICC (IBC) - International Building Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- D. NFPA 80 - Standard for Fire Doors and Other Opening Protectives; 2025.

1.04 SUBMITTALS

- A. Product Data: Indicate door core materials and construction; veneer species, type and characteristics.
- B. Shop Drawings: Show doors and frames, elevations, sizes, types, swings, undercuts, beveling, blocking for hardware, factory machining, factory finishing, cutouts for glazing and other details.
- C. Samples: Submit two samples of door facing illustrating color and texture.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing work of the type specified in this section, with not less than three years of documented experience.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Wood Veneer Faced Doors:
 - 1. Masonite Architectural; Aspiro Select Wood Veneer Doors: www.architectural.masonite.com/#sle.
 - 2. Oregon Door: www.oregondoor.com/#sle.
 - 3. VT Industries, Inc: www.vtindustries.com/#sle.

2.02 DOORS

- A. Doors: See drawings for locations and additional requirements.
 - 1. Quality Standard: Custom Grade, Heavy Duty performance, in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), unless noted otherwise.
 - 2. Wood Veneer Faced Doors: 5-ply unless otherwise indicated.
- B. Interior Doors: 1-3/4 inches (44 mm) thick unless otherwise indicated; flush construction.
 - 1. Provide solid core doors at each location.
 - 2. Fire Rated Doors: Tested to ratings indicated on drawings in accordance with ICC (IBC) - Positive Pressure; Underwriters Laboratories Inc (UL) labeled without any visible seals when door is open.

3. Wood veneer facing with factory transparent finish as indicated on drawings, wood species to match existing adjacent doors.
4. Wood veneer facing for field opaque finish as indicated on drawings.

2.03 DOOR CORES

- A. Non-Rated Solid Core and 20 Minute Rated Doors: Type particleboard core (PC), plies and faces as indicated.
- B. Fire-Rated Doors: Mineral core type, with fire resistant composite core (FD), plies and faces as indicated above; with core blocking as required to provide adequate anchorage of hardware without through-bolting.
- C. Bullet Resistant Doors: Equivalent to type, with bonded particleboard core (PC); rating; plies and faces as indicated above.

2.04 DOOR FACINGS

- A. Veneer Facing for Transparent Finish: Species as specified above, veneer grade in accordance with quality standard indicated, plain sliced (flat cut), with book match between leaves of veneer, running match of spliced veneer leaves assembled on door or panel face; unless existing doors differ..
- B. Veneer Facing for Opaque Finish: Medium density overlay (MDO), in compliance with indicated quality standard.

2.05 DOOR CONSTRUCTION

- A. Fabricate doors in accordance with door quality standard specified.
- B. Cores Constructed with stiles and rails:
 1. Provide solid blocks at lock edge for hardware reinforcement.
 2. Provide solid blocking for other throughbolted hardware.
- C. Factory machine doors for hardware other than surface-mounted hardware, in accordance with hardware requirements and dimensions.
- D. Factory fit doors for frame opening dimensions identified on shop drawings, with edge clearances in accordance with specified quality standard.
 1. Exception: Doors to be field finished.
- E. Provide edge clearances in accordance with the quality standard specified.

2.06 FINISHES - WOOD VENEER DOORS

- A. Finish work in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), Section 5 - Finishing for grade specified.
- B. Factory finish doors in accordance with approved sample.

2.07 ACCESSORIES

- A. Hollow Metal Door Frames: See Section 08 11 13.
- B. Door Window Frames: Door window frames with glazing securely fastened within door opening.
 1. Size: As indicated on drawings.
 2. Frame Material: 20 gauge (1 mm) cold rolled steel.
 3. Metal Finish: Baked enamel, match existing color in building.
 4. Manufacturers:
 - a. Anemostat; LoPro.
- C. Glazing: See Section 08 80 00.
- D. Door Hardware: See Section 08 71 00.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that opening sizes and tolerances are acceptable.
- C. Do not install doors in frame openings that are not plumb or are out-of-tolerance for size or alignment.

3.02 INSTALLATION

- A. Install doors in accordance with manufacturer's instructions and specified quality standard.
 - 1. Install fire-rated doors in accordance with NFPA 80 requirements.
- B. Factory-Finished Doors: Do not field cut or trim; if fit or clearance is not correct, replace door.
- C. Use machine tools to cut or drill for hardware.
- D. Coordinate installation of doors with installation of frames and hardware.
- E. Install door window frames plumb and level.

3.03 TOLERANCES

- A. Comply with specified quality standard for fit and clearance tolerances.
- B. Comply with specified quality standard for telegraphing, warp, and squareness.

3.04 ADJUSTING

- A. Adjust doors for smooth and balanced door movement.
- B. Adjust closers for full closure.

END OF SECTION

**SECTION 08 31 00
ACCESS DOORS AND PANELS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Wall- and ceiling-mounted access units.

1.02 RELATED REQUIREMENTS

- A. Section 09 91 23 - Interior Painting: Field paint finish.

1.03 REFERENCE STANDARDS

- A. ITS (DIR) - Directory of Listed Products; Current Edition.
- B. UL (FRD) - Fire Resistance Directory; Current Edition.

1.04 SUBMITTALS

- A. Product Data: Provide sizes, types, finishes, hardware, scheduled locations, and details of adjoining work.
- B. Shop Drawings: Indicate exact position of each access door and/or panel unit.

PART 2 PRODUCTS

2.01 ACCESS DOORS AND PANELS ASSEMBLIES

- A. Wall- and Ceiling-Mounted Units:
 - 1. Location: As indicated on drawings.
 - 2. Panel Material: Steel.
 - 3. Size: As indicated on Drawings.
 - 4. Door/Panel: Hinged, standard duty, with key-operated cylinder lock and no handle.
 - 5. Wall Mounting Criteria: Provide surface-mounted face frame and door surface flush with frame surface.
- B. Fire-Rated Wall- and Ceiling-Mounted Units:
 - 1. Location: As indicated on drawings.
 - 2. Wall Fire-Rating: As indicated on drawings.
 - 3. Panel Material: Steel.
 - 4. Size: As indicated on drawings..
 - 5. Door/Panel: Insulated double-surface panel, key-operated cylinder lock and no handle.

2.02 WALL- AND CEILING-MOUNTED ACCESS UNITS

- A. Manufacturers:
 - 1. Basis of Design: Subject to requirements, provide Karp Associates, Inc:
www.karpinc.com/#sle, or a comparable product by one of the other listed manufacturers.
 - a. Non-rated: DSC-214M.
 - b. Fire-rated: KRP-150 FR or KRP-250 FR.
 - 2. Activar Construction Products Group, Inc. - JL Industries: www.activarcpg.com/#sle.
 - 3. Babcock-Davis: www.babcockdavis.com/#sle.
 - 4. Bilco: www.bilco.com.
 - 5. Milcor Inc.: www.milcorinc.com/access-doors.
 - 6. Nystrom, Inc: www.nystrom.com/#sle.
- B. Wall- and Ceiling-Mounted Units: Factory-fabricated door and frame, fully assembled units with corner joints welded, filled and ground flush; square and without rack or warp; coordinate requirements with type of installation assembly being used for each unit.
 - 1. Frames: 16-gauge, 0.0598-inch (1.52 mm) minimum thickness.
 - 2. Heavy-Duty Single Steel Sheet Door Panels: 14-gauge, 0.0747-inch (1.89 mm) minimum thickness.

3. Units in Fire-Rated Assemblies: Fire rating as required by applicable code for fire-rated assembly that access doors are being installed.
 - a. Provide products listed by ITS (DIR) or UL (FRD) as suitable for purpose indicated.
4. Steel Finish: Primed.
5. Hardware:
 - a. Hardware for Fire-Rated Units: As required for listing.
 - b. Hinges for Non-Fire-Rated Units: Concealed, constant force closure spring type.
 - c. Latch/Lock: Cylinder lock-operated cam latch, two keys for each unit.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that rough openings are correctly sized and located.
- B. Begin installation only after substrates have been properly prepared, and if the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION

- A. Clean surfaces thoroughly prior to proceeding with this work.
- B. Prepare surfaces using methods recommended by manufacturer for applicable substrates in accordance with project conditions.

3.03 INSTALLATION

- A. Install units in accordance with manufacturer's instructions.
- B. Install frames plumb and level in openings, and secure units rigidly in place.
- C. Position units to provide convenient access to concealed equipment when necessary.

END OF SECTION

SECTION 08 43 13
ALUMINUM-FRAMED STOREFRONTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Aluminum-framed storefront, with vision glass.
- B. Aluminum doors and frames.
- C. Weatherstripping.

1.02 RELATED REQUIREMENTS

- A. Section 08 44 13 - Glazed Aluminum Curtain Walls.
- B. Section 08 71 00 - Door Hardware: Hardware items other than specified in this section.
- C. Section 08 80 00 - Glazing: Glass and glazing accessories.

1.03 REFERENCE STANDARDS

- A. AAMA CW-10 - Care and Handling of Architectural Aluminum from Shop to Site; 2015.
- B. AAMA 503 - Voluntary Specification for Field Testing of Newly Installed Storefronts, Curtain Walls and Sloped Glazing Systems; 2014.
- C. AAMA 611 - Specification for Anodized Architectural Aluminum; 2024.
- D. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2021.
- E. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric); 2021.
- F. ASTM E283/E283M - Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Skylights, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen; 2019.
- G. ASTM E330/E330M - Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference; 2014 (Reapproved 2021).
- H. ASTM E783 - Standard Test Method for Field Measurement of Air Leakage Through Installed Exterior Windows and Doors; 2002 (Reapproved 2018).
- I. ASTM E1105 - Standard Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls, by Uniform or Cyclic Static Air Pressure Difference; 2015 (Reapproved 2023).
- J. FLA (PAD) - Florida Building Code Online - Product Approval Directory; Current Edition.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate with installation of other components that comprise the exterior enclosure.
- B. Preinstallation Meeting: Conduct a preinstallation meeting one week before starting work of this section; require attendance by all affected installers.

1.05 SUBMITTALS

- A. Product Data: Provide component dimensions, describe components within assembly, anchorage and fasteners, glass and infill, door hardware, and internal drainage details.
- B. Shop Drawings: Indicate system dimensions, framed opening requirements and tolerances, affected related work, expansion and contraction joint location and details, and field welding required.
- C. Samples: Submit two samples illustrating finished aluminum surface, glass, glazing materials.

- D. Hardware Schedule: Complete itemization of each item of hardware to be provided for each door, cross-referenced to door identification numbers in Contract Documents.
- E. Field Quality Control Submittals: Report of field testing for water penetration and air leakage.

1.06 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing work of type specified and with at least three years of documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Handle products of this section in accordance with AAMA CW-10.
- B. Protect finished aluminum surfaces with wrapping. Do not use adhesive papers or sprayed coatings that bond to aluminum when exposed to sunlight or weather.

1.08 FIELD CONDITIONS

- A. Do not install sealants when ambient temperature is less than 40 degrees F (5 degrees C). Maintain this minimum temperature during and 48 hours after installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Aluminum-Framed Storefronts:
 - 1. Arcadia, Inc: www.arcadiainc.com/#sle.
 - 2. Boyd Aluminum: www.boydaluminum.com/#sle.
 - 3. Kawneer North America: www.kawneer.com/#sle.
 - 4. Oldcastle BuildingEnvelope: www.oldcastlebe.com/#sle.

2.02 BASIS OF DESIGN -- FRAMING FOR INSULATING GLAZING

- A. Set Style as shown on Drawings, Wind-Borne-Debris Resistance Tested:
 - 1. Basis of Design: Kawneer North America; 451 Trifab: www.kawneer.com/#sle..
 - 2. Vertical Mullion Dimensions: 2 inches wide by 4-1/2 inches deep (50 mm wide by 114 mm deep).

2.03 BASIS OF DESIGN -- SWINGING DOORS

- A. Entrance Doors, Narrow Stile:
 - 1. Basis of Design: Kawneer 190 Entrance Door.
 - 2. Thickness: 1-3/4 inches (43 mm).

2.04 ALUMINUM-FRAMED STOREFRONT

- A. Aluminum-Framed Storefront: Factory fabricated, factory finished aluminum framing members with infill, and related flashings, anchorage and attachment devices.
 - 1. Vertical Mullion Dimensions: 2 inches wide by 4-1/2 inches deep (50 mm wide by 114 mm deep).
 - 2. Finish: Class I color anodized.
 - a. Factory finish all surfaces that will be exposed in completed assemblies.
 - 3. Fabrication: Joints and corners flush, hairline, and weatherproof, accurately fitted and secured; prepared to receive anchors and hardware; fasteners and attachments concealed from view; reinforced as required for imposed loads.
 - 4. Construction: Eliminate noises caused by wind and thermal movement, prevent vibration harmonics, and prevent "stack effect" in internal spaces.
 - 5. System Internal Drainage: Drain to the exterior by means of a weep drainage network any water entering joints, condensation occurring in glazing channel, and migrating moisture occurring within system.
 - 6. Expansion/Contraction: Provide for expansion and contraction within system components caused by cycling temperature range of 170 degrees F (95 degrees C) over a 12 hour

- period without causing detrimental effect to system components, anchorages, and other building elements.
7. Movement: Allow for movement between storefront and adjacent construction, without damage to components or deterioration of seals.
 8. Perimeter Clearance: Minimize space between framing members and adjacent construction while allowing expected movement.
- B. Performance Requirements
1. Wind Loads: Design and size components to withstand the specified load requirements without damage or permanent set, when tested in accordance with ASTM E330/E330M, using loads 1.5 times the design wind loads and 10 second duration of maximum load.
 - a. Member Deflection: Limit member deflection to flexure limit of glass in any direction, with full recovery of glazing materials.
 2. Wind-Borne-Debris Resistance: Identical full-size glazed assembly without auxiliary protection, having Florida Building Code FLA (PAD) approval for Large and Small Missile impact and pressure cycling at design wind pressure.
 3. Air Leakage: 0.06 cfm/sq ft (0.3 L/sec sq m) maximum leakage of storefront wall area when tested in accordance with ASTM E283/E283M at 1.57 psf (75 Pa) pressure difference.

2.05 COMPONENTS

- A. Aluminum Framing Members: Tubular aluminum sections, thermally broken with interior section insulated from exterior, drainage holes and internal weep drainage system.
1. Glazing Stops: Flush.
- B. Glazing: See Section 08 80 00.

2.06 MATERIALS

- A. Extruded Aluminum: ASTM B221 (ASTM B221M).
- B. Fasteners: Stainless steel.
- C. Glazing Gaskets: Type to suit application to achieve weather, moisture, and air infiltration requirements.

2.07 FINISHES

- A. Class I Color Anodized Finish: AAMA 611 AA-M12C22A42 Integrally colored anodic coating not less than 0.7 mils (0.018 mm) thick.
- B. Color: Dark bronze to match existing courthouse.

2.08 HARDWARE

- A. For each door, include weatherstripping, sill sweep strip, and threshold.
- B. Other Door Hardware: See Section 08 71 00.
- C. Weatherstripping: Wool pile, continuous and replaceable; provide on all doors.
- D. Sill Sweep Strips: Resilient seal type, retracting, of neoprene; provide on all doors.
- E. Threshold: Extruded aluminum, one piece per door opening, ribbed surface; provide on all doors.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install wall system in accordance with manufacturer's instructions.
- B. Attach to structure to permit sufficient adjustment to accommodate construction tolerances and other irregularities.
- C. Provide alignment attachments and shims to permanently fasten system to building structure.

- D. Align assembly plumb and level, free of warp or twist. Maintain assembly dimensional tolerances, aligning with adjacent work.
- E. Provide thermal isolation where components penetrate or disrupt building insulation.
- F. Install sill flashings. Turn up ends and edges; seal to adjacent work to form water tight dam.
- G. Where fasteners penetrate sill flashings, make watertight by seating and sealing fastener heads to sill flashing.
- H. Pack fibrous insulation in shim spaces at perimeter of assembly to maintain continuity of thermal barrier.
- I. Set thresholds in bed of sealant and secure.
- J. Touch-up minor damage to factory applied finish; replace components that cannot be satisfactorily repaired.

3.02 FIELD QUALITY CONTROL

- A. Provide field testing of installed storefront system by independent laboratory in accordance with AAMA 503 during construction process and before installation of interior finishes.
 - 1. Perform a minimum of two tests in each designated area as indicated on drawings.
 - 2. Conduct tests in each area prior to 10 percent and 50 percent completion of this work.
 - 3. Field test for water penetration in accordance with ASTM E1105 with uniform static air pressure difference (Procedure A) not less than 4.18 psf (200 Pa).
 - a. Maximum allowable rate of water penetration in 15-minute test is 0.5 ounce (14 gram) that is not contained in an area with provisions to drain to exterior, or collected on surface of interior horizontal framing member.
 - 4. Field test for air leakage in accordance with ASTM E783 with uniform static air pressure difference of 1.57 psf (75 Pa).

3.03 ADJUSTING

- A. Adjust operating hardware and sash for smooth operation.

3.04 CLEANING

- A. Remove protective material from pre-finished aluminum surfaces.
- B. Wash down surfaces with a solution of mild detergent in warm water, applied with soft, clean wiping cloths, and take care to remove dirt from corners and to wipe surfaces clean.

3.05 PROTECTION

- A. Protect installed products from damage until Date of Substantial Completion.

END OF SECTION

**SECTION 08 53 13
VINYL WINDOWS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Vinyl-framed, factory-glazed windows.

1.02 RELATED REQUIREMENTS

- A. Section 07 27 00 - Air Barriers: Sealing frames to air barrier installed on adjacent construction.
- B. Section 07 92 00 - Joint Sealants: Sealing joints between frames and adjacent construction.

1.03 REFERENCE STANDARDS

- A. AAMA/WDMA/CSA 101/I.S.2/A440 - North American Fenestration Standard/Specification for Windows, Doors, and Skylights; 2022, with Errata (2023).

1.04 SUBMITTALS

- A. Product Data: Provide component dimensions, anchors, fasteners, and glass.
- B. Shop Drawings: Indicate opening dimensions, framed opening tolerances, affected related work, and installation requirements.
- C. Samples: 4 by 4 inch (102 by 102 mm) in size, showing finished surfaces.
- D. Installer's qualification statement.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing work of type specified, with minimum 3 years of documented experience.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Vinyl Windows:
 - 1. Basis of Design: Pella Corporation; Custom: www.pellacommercial.com/#sle.
 - 2. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 DESCRIPTION

- A. Vinyl Windows: Factory-fabricated frame and sash members of extruded, hollow, ultraviolet-resistant, glass-fiber reinforced polyvinyl chloride (PVC) with integral color; with factory-installed glazing, related flashings, anchorage and attachment devices.
 - 1. Configuration: As indicated on drawings.
 - a. Product Type: FW - Fixed window in accordance with AAMA/WDMA/CSA 101/I.S.2/A440.
 - 2. Interior Color: Custom color as selected by Architect.
 - 3. Exterior Color: Custom color as selected by Architect.
 - 4. Size to fit openings with minimum clearance around perimeter of assembly providing necessary space for perimeter seals.
 - 5. System Internal Drainage: Drain to exterior side by means of weep drainage network any water entering joints, condensation within glazing channel, or other migrating moisture within system.
 - 6. Glazing Stops, Trim, Flashings, and Accessory Pieces: Formed of rigid PVC, fitting tightly into frame assembly.

2.03 COMPONENTS

- A. Glazing: Insulated double pane, annealed glass, clear, low-E coated, with metal edge spacer, with glass thicknesses as recommended by manufacturer for specified wind conditions.
- B. Frame Depth: Manufacturer's standard.

- C. Fasteners: Stainless steel.
- D. Accessories: Provide related flashings, anchorage and attachment devices as necessary for full assembly.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install window unit assemblies in accordance with manufacturers instructions and applicable building codes.
- B. Attach window frame and shims to perimeter opening to accommodate construction tolerances and other irregularities as necessary.
- C. Align window plumb and level, free of warp or twist, and maintain dimensional tolerances and alignment with adjacent work.

END OF SECTION

SECTION 08 56 59
SERVICE AND TELLER WINDOW UNITS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Service and teller window units with pass-through device.

1.02 RELATED REQUIREMENTS

- A. Section 07 92 00 - Joint Sealants: Sealing joints between frames and adjacent construction.

1.03 REFERENCE STANDARDS

- A. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2021.
- B. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric); 2021.
- C. UL (DIR) - Online Certifications Directory; Current Edition.

1.04 SUBMITTALS

- A. Product Data: Submit manufacturer's product data for specified products indicating materials, operation, glazing, finishes, and installation instructions.
- B. Shop Drawings: Indicate configuration, sizes, rough-in, mounting, anchors and fasteners, and installation clearances.
- C. Installer Qualification Statement.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience.

1.06 WARRANTY

- A. Workmanship Warranty: All materials shall be warranted against defects for a period of [1] year for the date of receipt at the project site. Provide certificates of manufacturer's standard limited warranty with closeout documents.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Service and Teller Window Units:
 - 1. Basis of Design: As indicated on Drawings or provide a equal product by one of the following
 - 2. Quikserv: www.quikserv.com/#sle.
 - 3. Ready Access, Inc: www.ready-access.com/#sle.
 - 4. Total Security Solutions.

2.02 PERFORMANCE CRITERIA

- A. Ballistic Resistant:
 - 1. Level 1 in accordance with UL 752 – Testing for Ballistic Resistance for the complete assembly including framing, glazing and panels.

2.03 SERVICE AND TELLER WINDOW UNITS WITH PASS-THROUGH DEVICE

- A. Location: Built within interior wall, as indicated on drawings.
- B. Type of Use: Walk-up.
- C. Window Type: Fixed.
 - 1. Overall Window Frame Size: As indicated on drawings.
 - 2. Frame Material: Aluminum.

- D. Glazing: Refer to Drawings, clear.
- E. Pass-Through Device: Deal tray in counter below window.
 - 1. Material (tray): Stainless steel.
 - 2. Material (counter): Solid surface.

2.04 ASSEMBLY COMPONENTS

- A. Windows: Factory-fabricated, finished, and glazed, with extruded aluminum frame and glazing stops UON; complete with hardware and anchors.
 - 1. Provide window units that are re-glazable from the secure side without dismantling the non-secure side of framing.
 - 2. Rigidly fit and secure joints and corners with internal reinforcement. Make joints and connections flush, hairline, and weatherproof. Fully weld corners.
 - 3. Apply factory finish to exposed surfaces.
- B. Deal Tray: Integral with window sill.
 - 1. Material: One piece stainless steel tray construction, 18 gauge, 0.0500 inch (1.27 mm) minimum thickness.

2.05 MATERIALS

- A. Aluminum Extrusions: Minimum 1/8 inch (3.2 mm) thick frame and sash material complying with ASTM B221 and ASTM B221M.
 - 1. Finish: Class I natural anodized.
- B. Stainless Steel: 18 gauge Type 304 with Brushed No. 4 finish.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that window openings are ready for installation of windows.
- B. Verify that correct embedded anchors are in place and in proper location; repair or replace anchors as required to achieve satisfactory installation.
- C. Notify Architect if conditions are not suitable for installation of units; do not proceed until conditions are satisfactory.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install units in correct orientation (inside/outside or secure/non-secure).
- C. Anchor units securely in manner so as to achieve performance specified.

3.03 CLEANING

- A. Remove protective material from factory finished surfaces.
- B. Clean exposed surfaces promptly after installation without damaging finishes.

3.04 PROTECTION

- A. Provide temporary protection to ensure that service and teller windows are without damage upon Date of Substantial Completion.

END OF SECTION

**SECTION 08 71 00
DOOR HARDWARE**

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. This Section includes items known commercially as finish or door hardware that are required for swing, sliding, and folding doors, except special types of unique hardware specified in the same sections as the doors and door frames on which they are installed.
- B. This Section includes the following, but is not necessarily limited to:
 - 1. Door Hardware, including electric hardware.
 - 2. Wall-mounted electromagnetic hold-open devices.
 - 3. Low-energy door operators plus sensors and actuators.
 - 4. Thresholds, gasketing and weather-stripping.
- C. Related Sections: The following sections are noted as containing requirements that relate to this Section, but may not be limited to this listing.
 - 1. Division 8: Section - Steel Doors and Frames.

1.03 REFERENCES (USE DATE OF STANDARD IN EFFECT AS OF BID DATE.)

- A. 2021 Alaska Building Code
- B. BHMA – Builders' Hardware Manufacturers Association
- C. DHI – Door and Hardware Institute
- D. NFPA - National Fire Protection Association.
 - 1. NFPA 80 - Fire Doors and Other Opening Protectives
 - 2. NFPA 105 - Smoke and Draft Control Door Assemblies
- E. UL - Underwriters Laboratories.
 - 1. UL 10C - Fire Tests of Door Assemblies
 - 2. UL 305 - Panic Hardware
- F. WHI - Warnock Hersey Incorporated
- G. SDI - Steel Door Institute

1.04 SUBMITTALS & SUBSTITUTIONS

- A. General: Submit in accordance with Conditions of the Contract and Division 1 Specification sections.
- B. Submit product data (catalog cuts) including manufacturers' technical product information for each item of door hardware, installation instructions, maintenance of operating parts and finish, and other information necessary to show compliance with requirements.
- C. Submit Electronic copy of schedule organized vertically into "Hardware Sets" with index of doors and headings, indicating complete designations of every item required for each door or opening. Include following information:
 - 1. Include a Cover Sheet with;
 - a. Job Name, location, telephone number.
 - b. Architects name, location and telephone number.
 - c. Contractors name, location, telephone number and job number.
 - d. Suppliers name, location, telephone number and job number.
 - e. Hardware consultant's name, location and telephone number.
 - 2. Job Index information included;

- a. Numerical door number index including; door number, hardware heading number and page number.
 - b. Complete keying information (referred to DHI hand-book "Keying Systems and Nomenclature"). Provision should be made in the schedule to provide keying information when available; if it is not available at the time the preliminary schedule is submitted.
 - c. Manufacturers' names and abbreviations for all materials.
 - d. Explanation of abbreviations, symbols, and codes used in the schedule.
 - e. Mounting locations for hardware.
 - f. Clarification statements or questions.
 - g. Catalog cuts and manufacturer's technical data and instructions.
3. Vertical schedule format sample:
- 4.

Heading Number 1 (Hardware group or set number – HW -1)					
			(a) 1 Single Door #1 - Exterior from Corridor 101	(b) 90°	(c) RH
			(d) 3' 0"x7' 0" x 1-3/4" x (e) 20 Minute (f) WD x HM		
(g) 1	(h)	(i) ea	(j) Hinges - (k) 5BB1HW 4.5 x 4.5 NRP (l) ½ TMS	(m) 626	(n) IVE
2	6AA	1 ea	Lockset - ND50PD x RHO x RH x 10-025 x JTMS	626	SCH

(a) - Single or pair with opening number and location. (b) - Degree of opening (c) - Hand of door(s) (d) - Door and frame dimensions and door thickness. (e) - Label requirements if any. (f) - Door by frame material. (g) - (Optional) Hardware item line #. (h) - Keyset Symbol. (i) - Quantity. (j) - Product description. (k) - Product Number. (l) - Fastenings and other pertinent information. (m) - Hardware finish codes per ANSI A156.18. (n) - Manufacture abbreviation.

- D. Make substitution requests in accordance with Division 1. Substitution requests must be made prior to bid date. Include product data and indicate benefit to the project. Furnish samples of any proposed substitution.
- E. Keying Schedule: Submit separate detailed schedule indicating clearly how the Owner's final instructions on keying of locks has been fulfilled.
- F. Templates for doors, frames, and other work specified to be factory prepared for the installation of door hardware. Check shop drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.
- G. Furnish as-built/as-installed schedule with close-out documents, including keying schedule and transcript, wiring/riser diagrams, manufacturers' installation and adjustment and maintenance information.
- H. Fire Door Assembly Testing: Submit a written record of each fire door assembly to the Owner to be made available to the Authority Having Jurisdiction (AHJ) for future building inspections.

1.05 QUALITY ASSURANCE

- A. Obtain each type of hardware (latch and lock sets, hinges, closers, exit devices, etc.) from a single manufacturer.
- B. Supplier Qualifications: A recognized architectural door hardware supplier, with warehousing facilities in the project's vicinity, that has a record of successful in-service performance for supplying door hardware similar in quantity, type, and quality to that indicated for this project and that employs an experienced architectural hardware consultant (AHC) who is available to

Owner, Architect, and Contractor, at reasonable times during the course of the Work, for consultation.

1. Responsible for detailing, scheduling and ordering of finish hardware.
 2. Meet with Owner to finalize keying requirements and to obtain final instructions in writing.
 3. Stock parts for products supplied and are capable of repairing and replacing hardware items found defective within warranty periods.
- C. Hardware Installer: Company specializing in the installation of commercial door hardware with five years documented experience.
- D. Fire-Rated Openings: Provide door hardware for fire-rated openings that complies with NFPA Standard No. 80 and requirements of authorities having jurisdiction. Provide only items of door hardware that are listed and tested by UL or Warnock Hersey for given type/size opening and degree of label. Provide proper latching hardware, door closers, approved-bearing hinges and seals whether listed in the Hardware Schedule or not.
1. Where emergency exit devices are required on fire-rated doors, (with supplementary marking on doors' UL labels indicating "Fire Door to be Equipped with Fire Exit Hardware") provide UL label on exit devices indicating "Fire Exit Hardware".
- E. Exit Doors: Operable from inside with single motion without the use of a key or special knowledge or effort.

1.06 COORDINATION

- A. Installation Templates: Distribute for doors, frames, and other work specified to be factory or shop prepared. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.
- B. Security: Coordinate installation of door hardware, keying, and access control with Owner's security consultant.
- C. Electrical System Roughing-In: Coordinate layout and installation of electrified door hardware with connections to power supplies and building safety and security systems.

1.07 DELIVERY, STORAGE AND HANDLING

- A. Coordinate delivery of packaged hardware items to the appropriate locations (shop or field) for installation.
- B. Hardware items shall be individually packaged in manufacturers' original containers, complete with proper fasteners. Clearly mark packages on outside to indicate contents and locations in hardware schedule and in work.
- C. Provide locked storage area for hardware, protect from moisture, sunlight, paint, chemicals, etc.
- D. Inventory door hardware jointly with representatives of hardware supplier and hardware installer until each is satisfied that count is correct.

1.08 WARRANTY

- A. Provide warranties of respective manufacturers' regular terms of sale from day of final acceptance as follows:
1. Mechanical Locksets: Ten (10) years.
 2. Electro-mechanical locksets: Three (3) years
 3. Closers: Thirty (30) years
 4. Mechanical exit devices: Ten (10) years
 5. Electro-mechanical exit devices: Five (5) years
 6. All other hardware: Three (3) years.

1.09 MAINTENANCE

- A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

1.10 PRE-INSTALLATION CONFERENCE

- A. Convene a pre-installation conference at least one week prior to beginning work of this section.
- B. Attendance: Architect, Construction Manager, Contractor, Security Contractor, Hardware Supplier, Installer, Key District Personnel, and Project Inspector.
- C. Agenda: Review hardware schedule, products, installation procedures and coordination required with related work. Review District's keying standards.

PART 2 PRODUCTS

2.01 MANUFACTURERS

<u>Item</u>	<u>Manufacturer</u>	<u>Acceptable Substitutes</u>
Hinges	Ives	Hager, Stanley, McKinney
Locks, Latches	Schlage	Owner Standard
Cylinders	Medeco	Owner Standard
Exit Devices	Von Duprin	Or Approved Equal
Closers	LCN	Or Approved Equal
Push, Pulls	Ives	Trimco
Protection Plates	Ives	Trimco
Flush Bolts	Ives	Trimco
Dust Proof Strikes	Ives	Trimco
Coordinators	Ives	Trimco
Stops	Ives	Trimco
Overhead Stops	Glynn-Johnson	Or Approved Equal
Thresholds	Zero	National Guard Product, Pemko
Seals & Bottoms	Zero	National Guard Product, Pemko

2.02 MATERIALS

- A. Hinges: Exterior out-swinging door butts shall be non-ferrous material and shall have stainless steel hinge pins. All doors to have non-rising pins.
 - 1. Hinges shall be sized in accordance with the following:
 - a. Height:
 - 1) Doors up to 42" wide: 4-1/2" inches.
 - 2) Doors 43" to 48" wide: 5 inches.
 - b. Width: Sufficient to clear frame and trim when door swings 180 degrees.
 - c. Number of Hinges: Furnish 3 hinges per leaf to 7'-5" in height. Add one for each additional 2 feet in height.
 - 2. Furnish non-removable pins (NRP) at all exterior out-swing doors and interior key lock doors with reverse bevels.
 - 3. Provide hinges with electrified options as scheduled in the hardware sets. Provide with sufficient number and wire gage to accommodate electric function of specified hardware. Locate electric hinge at second hinge from bottom or nearest to electrified locking component. Doors and frames to be factory prepped for thru wire hinges.
- B. Heavy Duty Cylindrical Locks and Latches: Schlage "ND" Series as scheduled with "Rhodes" design, fastened with through-bolts and threaded chassis hubs.
 - 1. Provide cylindrical locksets exceeding the ANSI/BHMA A156.2 Grade 1 performance standards for strength, security, and durability in the categories below:
 - a. Abusive Locked Lever Torque Test: Minimum 3,100 inch-pounds without gaining access.
 - b. Offset lever pull: Minimum 1,600 foot pounds without gaining access.
 - c. Vertical lever impact: Minimum 100 impacts without gaining access.
 - 2. Cycle life: Tested to minimum 16 million cycles per ANSI/BHMA A156.2 Cycle Test with no visible lever sag or use of performance aids such as set screws or spacers

3. UL 10C for 4'-0" x 10'-0" 3-hour fire door.
 4. Cylinders: Refer to "KEYING" article, herein.
 5. Provide solid steel anti-rotation through bolts and posts to control excessive rotation of lever.
 6. Provide lockset that allows lock function to be changed to over twenty other common functions by swapping easily accessible parts.
 7. Provide locks with standard 2-3/4 inches (70 mm) backset, unless noted otherwise, with 1/2 inch latch throw capable of UL listing of 3 hours on a 4' x 10' opening. Provide proper latch throw for UL listing at pairs.
 8. Provide locksets with separate anti-rotation thru-bolts, and no exposed screws.
 9. Provide independently operating levers with two external return spring cassettes mounted under roses to prevent lever sag.
 10. Provide standard ASA strikes unless extended lip strikes are necessary to protect trim.
 11. Lever Trim: Solid cast levers without plastic inserts, and wrought roses on both sides.
- C. Schlage "L" Series as scheduled with "06" Style Lever and "L" Style Escutcheon.
1. Locksets to comply with ANSI A156.13, Series 1000, Operational Grade 1 and Security Grade 1 with all standard trims. Locksets shall also comply with UL10C Positive Pressure requirements
 2. Lock case shall be manufactured with heavy 12 gauge steel with fully wrapped design. Lock cases with exposed edges are not acceptable. Lock case shall be multi-functional allowing transformation to a different function without opening lock case.
 3. Latchbolt shall have 3/4" throw and be non-handed, field reversible without opening the lock case. Solid latchbolts and / or plastic anti-friction devices are not acceptable.
 4. The deadbolt, when used, shall be 1" throw stainless steel with a 3/4" internal engagement when fully extended.
 5. All trim shall be through-bolted with the spring cages supporting the trim attached to the lock cases to prevent torqueing.
 6. Levers to have independent rotation in both directions. Exterior lever assembly to be one-piece design attached by threaded bushing. Interior lever assembly shall be attached by screwless shank
 7. Thru-bolt lever assemblies through the door for positive interlock. Locks using a through the door spindle for attachment are not acceptable. Spindles shall be independent, designed to "break-away" at a maximum of 75psi torque.
 8. Hand of lock chassis to be changeable by simply moving one screw from one side to the case to the other and pulling and reversing the latchbolt.
 9. Cylinders to be secured by a cast stainless steel, dual retainer. Locks utilizing screws and / or stamped retainers are not acceptable.
- D. Exit devices: Von Duprin as scheduled.
1. Provide certificate by independent testing laboratory that device has completed over 1,000,000 cycles and can still meet ANSI/BHMA A156.3 - 2001 standards.
 2. All internal parts shall be of cold-rolled steel with zinc dichromate coating.
 3. Mechanism case shall have an average thickness of .140".
 4. Compression spring engineering.
 5. Non-handed basic device design with center case interchangeable with all functions.
 6. All devices shall have quiet return fluid dampeners.
 7. All latchbolts shall be deadlocking with 3/4" throw and have a self-lubricating coating to reduce friction and wear.
 8. Device shall bear UL label for fire and or panic as may be required.
 9. All surface strikes shall be roller type and utilize a plate underneath to prevent movement.
 10. Lever Trim: "Breakaway" design, forged brass or bronze escutcheon with a minimum of .130" thickness, match lockset lever design.

11. Removable Mullions: Removable with single turn of building key. Securely reinstalled without need for key.
 12. Furnish glass bead kits for vision lites where required.
 13. All Exit Devices to be sex-bolted to the doors.
 14. Panic Hardware shall comply with CBC Section 11B.404.2.7 and shall be mounted between 34" and 44" above the finished floor surface.
 - a. The unlatching force shall not exceed 15 lbs. applied in the direction of travel.
- E. Closers: LCN as scheduled. Place closers inside building, stairs, room, etc.
1. Door closer cylinders shall be of high strength cast iron construction with double heat treated pinion shaft to provide low wear operating capabilities of internal parts throughout the life of the installation. All door closers shall be tested to ANSI/BHMA A156.4 test requirements by a BHMA certified testing laboratory. A written certification showing successful completion of a minimum of 10,000,000 cycles must be provided.
 2. All door closers shall be fully hydraulic and have full rack and pinion action with a shaft diameter of a minimum of 1 1/16 inch and piston diameter of 1 inch to ensure longevity and durability under all closer applications.
 3. All parallel arm closers shall incorporate one piece solid forged steel arms with bronze bushings. 1-9/16" steel stud shoulder bolts, shall be incorporated in regular arms, hold-open arms, arms with hold open and stop built in. All other closers to have forged steel main arms for strength, durability, and aesthetics for versatility of trim accommodation, high strength and long life.
 4. All parallel arm closers so detailed shall provide advanced backcheck for doors subject to severe abuse or extreme wind conditions. This advanced backcheck shall be located to begin cushioning the opening swing of the door at approximately 45 degrees. The intensity of the backcheck shall be fully adjustable by tamper resistant non-critical screw valve.
 5. Closers shall be installed to permit doors to swing 180 degrees.
 6. All closers shall utilize a stable fluid withstanding temperature range of 120 degrees F. to -30 degrees F. without requiring seasonal adjustment of closer speed to properly close the door.
 7. Provide the manufactures drop plates, brackets and spacers as required at narrow head rails and special frame conditions. NO wood plates or spacers will be allowed.
 8. Maximum effort to operate closers shall not exceed 5 lbs., such pull or push effort being applied at right angles to hinged doors. Compensating devices or automatic door operators may be utilized to meet the above standards. When fire doors are required, the maximum effort to operate the closer may be increased but shall not exceed 15 lbs. when specifically approved by fire marshal. All closers shall be adjusted to operate with the minimum amount of opening force and still close and latch the door. These forces do not apply to the force required to retract latch bolts or disengage other devices that hold the door in a closed position. Door shall take at least 5 seconds to move from an open position of 90 degrees to a position of 12 degrees from the latch jamb.
- F. Low Energy Auto Operators
1. Electro-Mechanical Automatic Operators - LCN Senior Swing as scheduled.
 - a. Provide low energy automatic operator units that are electro-mechanical design complying with ANSI/BHMA A156.19.
 - b. Opening: Powered by DC motor working through reduction gears.
 - c. Closing: Spring force.
 - d. Manual, hydraulic, or chain drive closers: Not permitted.
 - e. Operation: Motor is off when door is in closing mode. Door can be manually operated with power on or off without damage to operator. Provide variable adjustments, including opening and closing speed adjustment.
 - f. Cover: Aluminum.

- g. Provide units with manual off/auto/hold-open switch, push and go function to activate power operator, vestibule interface delay, electric lock delay, hold-open delay adjustable from 2 to 30 seconds, and logic terminal to interface with accessories, mats, and sensors.
 - h. Provide drop plates, brackets, or adapters for arms as required to suit details.
 - i. Provide hard-wired motion sensors and/or actuator switches for operation as specified. Provide weather-resistant actuators at exterior applications.
 - j. Provide complete assemblies of controls, switches, power supplies, relays, and parts/material recommended and approved by manufacturer of automatic operator for each individual leaf. Actuators control both doors simultaneously at pairs. Sequence operation of exterior and vestibule doors with automatic operators to allow ingress or egress through both sets of openings as directed by Architect. Locate actuators, key switches, and other controls as directed by Architect.
 - k. Provide caution signs as described in ANSI/BHMA A156.19.
 - 2. Accessories
 - a. Signage: As required by cited BHMA standard for type of door and its operation.
 - 1) Provide sign materials with instructions for field application when operators are installed.
 - b. Operator controls
 - 1) Vertical, Full Length Switches (Actuators): LCN 8310-856T wall-mounted, door-control switch plate for operation by touch. Install a wall push plate actuator on each side of each automatic swinging entrance door.
 - 2) Provide each actuator with a decal to be applied adjacent to the actuator instructing the user as to the operation and function of the door.
- G. Door Stops:
 - 1. Unless otherwise noted in Hardware Sets, provide floor type with appropriate fasteners. Where floor type cannot be used, provide wall type. If neither can be used, provide overhead type.
 - 2. Do not install floor stops more than four (4) inches from the face of the wall or partition.
 - 3. Provide backing plate at wall framing behind wall type.
 - 4. Overhead stops shall be made of stainless steel and non-plastic mechanisms and finished metal end caps. Field-changeable hold-open, friction and stop-only functions.
- H. Protection Plates: Fabricate either kick, armor, or mop plates with four beveled edges. Provide kick plates 10" high and 2" LDW. Sizes of armor and mop plates shall be listed in the Hardware Schedule. Furnish with machine or wood screws of bronze or stainless to match other hardware.
- I. Seals: Provide silicone gasket at all rated and exterior doors.
 - 1. Fire-rated Doors, Resilient Seals: UL10C Classified complies with NFPA 80 & NFPA 252. Coordinate with selected door manufacturers' and selected frame manufacturers' requirements.
 - 2. Fire-rated Doors, Intumescent Seals: Furnished by selected door manufacturer. Furnish fire-labeled opening assembly complete and in full compliance with UL10C Classified complies with NFPA 80 & NFPA 252. Where required, intumescent seals vary in requirement by door type and door manufacture -- careful coordination required.
 - 3. Smoke & Draft Control Doors: Provide UL10C Classified complies with NFPA 80 & NFPA 252 for use on "S" labeled Positive Pressure door assemblies.

2.03 KEYING

- A. Provide permanent cylinders masterkeyed into the existing keying system.
- B. Furnish all cylinders in Medeco Small Format Interchangeable Core (SFIC). Pack change keys independently (PKI).
- C. Furnish construction keying for doors requiring locking during construction.

- D. Furnish all keys with visual key control.
 - 1. Stamp key "Do Not Duplicate".
 - 2. Stamp (BHMA) key symbol on key.
- E. Furnish all cylinders with visual key control.
 - 1. Stamp (BHMA) key symbol on face of cylinder plug (VKC).
- F. Furnish mechanical keys as follows:
 - 1. Furnish 2 cut change keys for each different change key code.
 - 2. Furnish 2 cut control keys cut to the top masterkey for permanent I/C cylinders.
 - 3. Furnish 1 cut control key cut to each SKD combination.

2.04 FINISHES

- A. Generally to be satin chrome US26D (626 on bronze and 652 on steel) unless otherwise noted.
- B. Furnish push plates, pull plates and kick or armor plates in satin stainless steel US32D (630) unless otherwise noted.
- C. Door closers shall be powder-coated to match other hardware, unless otherwise noted.
- D. Aluminum items to be finished anodized aluminum except thresholds which can be furnished as standard mill finish.

2.05 FASTENERS

- A. Screws for strikes, face plates and similar items shall be flat head, countersunk type, provide machine screws for metal and standard wood screws for wood.
- B. Screws for butt hinges shall be flathead, countersunk, full-thread type.
- C. Fastening of closer bases or closer shoes to doors shall be by means of sex bolts and spray painted to match closer finish.
- D. Provide expansion anchors for attaching hardware items to concrete or masonry.
- E. All exposed fasteners shall have a phillips head.
- F. Finish of exposed screws to match surface finish of hardware or other adjacent work.
- G. All Exit Devices and Lock Protectors shall be fastened to the door by the means of sex bolts or through bolts.

PART 3 EXECUTION

3.01 INSPECTION

- A. Verify that doors and frames are square and plumb and ready to receive work and dimensions are as instructed by the manufacturer.
- B. Beginning of installation means acceptance of existing conditions.
- C. Fire-Rated Door Assembly Inspection: Upon completion of the installation, all fire door assemblies shall be inspected to confirm proper operation of the closing device and latching device and that only the manufacturer's furnished fasteners are used for installation and that it meets all criteria of a fire door assembly per NFPA 80 (Standard for Fire Doors and Other Opening Protectives) 2007 Edition. A written record shall be maintained and transmitted to the Owner to be made available to the Authority Having Jurisdiction (AHJ). The inspection of the swinging fire doors shall be performed by a certified FDAI (Fire Door Assembly Inspector) with knowledge and understanding of the operating components of the type of door being subjected to the inspection. The record shall list each fire door assembly throughout the project and include each door number, an itemized list of hardware set components at each door opening, and each door location in the facility.

3.02 INSTALLATION

- A. Install hardware in accordance with manufacturer's instructions and requirements of DHI.

- B. Use the templates provided by hardware item manufacturer.
- C. Mounting heights for hardware shall be as recommended by the Door and Hardware Institute. Operating hardware will to be located between 34" and 48" AFF.
- D. Set units level, plumb and true to line and location. Adjust and reinforce the attachment substrate as necessary for proper installation and operation.
- E. Drill and countersink units that are not factory-prepared for anchorage fasteners. Space fasteners and anchors in accordance with industry standards.
- F. Set thresholds for exterior doors in full bed of butyl-rubber sealant.
- G. If hand of door is changed during construction, make necessary changes in hardware at no additional cost.
- H. Hardware Installer shall coordinate with security contractor to route cable to connect electrified locks, panic hardware and fire exit hardware to power transfers or electric hinges at the time these items are installed so as to avoid disassembly and reinstallation of hardware.
- I. Hardware Installer shall also be present with the security contractor when the power is turned on for the testing of the electronic hardware applications. Installer shall make adjustments to solenoids, latches, vertical rods and closers to ensure proper and secure operation.
- J. All wiring for electro-mechanical hardware mounted on the door shall be connected through the power transfer and terminated in the interface junction box specified for in the Electrical Section.
- K. Conductors shall be minimum 18 gage stranded, multicolored. A minimum 12 in. loop of conductors shall be coiled in the interface junction box. Each conductor shall be permanently marked with its function.
- L. If a power supply is specified in the hardware sets, all conductors shall be terminated in the power supply. Make all connections required for proper operation between the power supply and the electro-mechanical hardware. Provide the proper size conductors as specified in the manufacturer's technical documentation.

3.03 ADJUST AND CLEAN

- A. Adjust and check each operating item of hardware and each door, to ensure proper operation or function of every unit. Replace units which cannot be adjusted to operate freely and smoothly as intended for the application made.
- B. Clean adjacent surface soiled by hardware installation.
- C. Final Adjustment: Wherever hardware installation is made more than one month prior to acceptance or occupancy, return to that work area and make final check and adjustment of all hardware items in such space or area. Clean operating items as necessary to restore proper function and finish of hardware and doors. Adjust door control devices to compensate for final operation of heating and ventilating equipment.
- D. Instruct Owner's Personnel in proper adjustment and maintenance of hardware finishes, during the final adjustment of hardware.
- E. Continued Maintenance Service: Approximately six months after the completion of the project, the Contractor accompanied by the Architectural Hardware Consultant, shall return to the project and re-adjust every item of hardware to restore proper functions of doors and hardware. Consult with and instruct Owner's personnel in recommended additions to the maintenance procedures. Replace hardware items which have deteriorated or failed due to faulty design, materials or installation of hardware units. Prepare a written report of current and predictable problems (of substantial nature) in the performance of the hardware.

3.04 HARDWARE LOCATIONS

- A. Conform to CCR, Title 24, Part 2; and ADAAG; and the drawings for access-compliant positioning requirements for the disabled.

3.05 FIELD QUALITY CONTROL

- A. Hardware supplier is responsible for providing the services of an Architectural Hardware Consultant (AHC) or a proprietary product technician to inspect installation and certify that hardware and its installation have been furnished and installed in accordance with manufacturers' instructions and as specified herein.

3.06 SCHEDULE

- A. The items listed in the following schedule shall conform to the requirements of the foregoing specifications.
- B. The Door Schedule on the Drawings indicates which hardware set is used with each door.

Abbreviation	Name
GLY	Glynn-Johnson Corp
HES	Hes Inc
IVE	H.B. Ives
JOH	Johnson Hardware
LCN	LCN Commercial Division
MED	Medeco High Security Locks Inc
NGP	National Guard Products Inc
SCH	Schlage Lock Company
TRM	Trimco
VON	Von Duprin

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GROUP NO. 01

1	EA	CONT. HINGE	112XY EPT	628	IVE
1	EA	POWER TRANSFER	EPT10	689	VON
1	EA	ELEC PANIC HARDWARE	RX-QEL-98-L-NL-06 24 VDC	626	VON
1	EA	SFIC RIM CYLINDER	KEYMARK X4	626	MED
1	EA	SURFACE CLOSER	4040XP SCUSH	689	LCN
1	EA	DRIP CAP	16A DW + 4"	A	NGP
1	SET	SEAL	WEATHERSTRIP BY FRAME MFR		
1	EA	DOOR SWEEP	C627A	CL	NGP
1	EA	THRESHOLD	PER DETAIL		
			CARD READER - WORK OF		
			DIVISION 28		
			POWER SUPPLY - WORK OF		
			DIVISION 28		

GROUP NO. 02

1	EA	ELECTRIC STRIKE	6000 SERIES CARD READER - WORK OF DIVISION 28 POWER SUPPLY - WORK OF DIVISION 28 BALANCE OF HARDWARE EXISTING TO REMAIN	630	VON

COORDINATE ELECTRIC STRIKE WITH EXISTING LOCKING HARDWARE

GROUP NO. 03

2	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	ELECTRIC HINGE	5BB1 4.5 X 4.5 TW8	652	IVE
1	EA	EU MORTISE LOCK	L9092HDEU 06L RX CON 12/24 VDC	626	SCH
1	EA	SFIC CYLINDER	KEYMARK X4	626	MED
1	EA	SURFACE CLOSER	4040XP EDA	689	LCN
1	EA	FLOOR STOP	1211	626	TRM
1	SET	SEAL	BY STC DOOR MFR		
1	SET	DOOR BOTTOM	BY STC DOOR MFR		
			CARD READER - WORK OF DIVISION 28 POWER SUPPLY - WORK OF DIVISION 28		

GROUP NO. 04

2	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	ELECTRIC HINGE	5BB1 4.5 X 4.5 TW8	652	IVE
1	EA	EU STOREROOM LOCK	ND80HDEU RHO RX CON 12V/24V DC	626	SCH
1	EA	SFIC CYLINDER	KEYMARK X4	626	MED
1	EA	SURFACE CLOSER	4040XP EDA	689	LCN
1	EA	FLOOR STOP	1211	626	TRM
1	SET	SEAL	BY STC DOOR MFR		
1	SET	DOOR BOTTOM	BY STC DOOR MFR		
			CARD READER - WORK OF DIVISION 28		
			POWER SUPPLY - WORK OF DIVISION 28		

GROUP NO. 05

2	EA	HINGE	5BB1HW 4.5 X 4.5	652	IVE
1	EA	ELECTRIC HINGE	5BB1HW 4.5 X 4.5 TW8	652	IVE
1	EA	EU STOREROOM LOCK	ND80HDEU RHO RX CON 12V/24V DC	626	SCH
1	EA	SFIC CYLINDER	KEYMARK X4	626	MED
1	EA	SURFACE CLOSER	4040XP EDA	689	LCN
1	EA	FLOOR STOP	1211	626	TRM
1	SET	SEAL	BY STC DOOR MFR		
1	SET	DOOR BOTTOM	BY STC DOOR MFR		
			CARD READER - WORK OF DIVISION 28		
			POWER SUPPLY - WORK OF DIVISION 28		

GROUP NO. 06

2	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	ELECTRIC HINGE	5BB1 4.5 X 4.5 TW8	652	IVE
1	EA	EU STOREROOM LOCK	ND80HDEU RHO RX CON 12V/24V DC	626	SCH
1	EA	SFIC CYLINDER	KEYMARK X4	626	MED
1	EA	SURFACE CLOSER	4040XP EDA	689	LCN
1	EA	KICK PLATE	KO050 10" X 2" LDW	630	TRM
1	EA	FLOOR STOP	1211	626	TRM
1	SET	SEAL	BY STC DOOR MFR		
1	SET	DOOR BOTTOM	BY STC DOOR MFR		
			CARD READER - WORK OF DIVISION 28		
			POWER SUPPLY - WORK OF DIVISION 28		

GROUP NO. 07

2	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	ELECTRIC HINGE	5BB1 4.5 X 4.5 TW8	652	IVE
1	EA	EU STOREROOM LOCK	ND80HDEU RHO RX CON 12V/24V DC	626	SCH
1	EA	SFIC CYLINDER	KEYMARK X4	626	MED
1	EA	SURFACE CLOSER	4040XP EDA	689	LCN
1	EA	KICK PLATE	KO050 10" X 2" LDW	630	TRM
1	EA	WALL STOP	1270WX	626	TRM
1	SET	SEAL	BY STC DOOR MFR		
1	SET	DOOR BOTTOM	BY STC DOOR MFR		
			CARD READER - WORK OF DIVISION 28		
			POWER SUPPLY - WORK OF DIVISION 28		

GROUP NO. 08

2	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	ELECTRIC HINGE	5BB1 4.5 X 4.5 TW8	652	IVE
1	EA	EU MORTISE LOCK	L9092HDEU 06L RX CON 12/24 VDC	626	SCH
1	EA	SFIC CYLINDER	KEYMARK X4	626	MED
1	EA	SURFACE CLOSER	4040XP	689	LCN
1	EA	KICK PLATE	KO050 10" X 2" LDW	630	TRM
1	EA	WALL STOP	1270WX	626	TRM
3	EA	SILENCER	SR64	GRY	IVE
			CARD READER - WORK OF DIVISION 28		
			POWER SUPPLY - WORK OF DIVISION 28		

GROUP NO. 09

2	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	ELECTRIC HINGE	5BB1 4.5 X 4.5 TW8	652	IVE
1	EA	EU MORTISE LOCK	L9092HDEU 06L RX CON 12/24 VDC	626	SCH
1	EA	SFIC CYLINDER	KEYMARK X4	626	MED
1	EA	SURFACE CLOSER	4040XP	689	LCN
1	EA	KICK PLATE	KO050 10" X 2" LDW	630	TRM
1	EA	FLOOR STOP	1211	626	TRM
1	SET	SEALS	5050B	BRN	NGP
			CARD READER - WORK OF DIVISION 28		
			POWER SUPPLY - WORK OF DIVISION 28		

GROUP NO. 10

2	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	ELECTRIC HINGE	5BB1 4.5 X 4.5 TW8	652	IVE
1	EA	EU STOREROOM LOCK	ND80HDEU RHO RX CON 12V/24V DC	626	SCH
1	EA	SFIC CYLINDER	KEYMARK X4	626	MED
1	EA	SURFACE CLOSER	4040XP EDA	689	LCN
1	EA	FLOOR STOP	1211	626	TRM
3	EA	SILENCER	SR64	GRY	IVE
CARD READER - WORK OF DIVISION 28					
POWER SUPPLY - WORK OF DIVISION 28					

GROUP NO. 11

2	EA	HINGE	5BB1HW 4.5 X 4.5	652	IVE
1	EA	ELECTRIC HINGE	5BB1HW 4.5 X 4.5 TW8	652	IVE
1	EA	EU STOREROOM LOCK	ND80HDEU RHO RX CON 12V/24V DC	626	SCH
1	EA	SFIC CYLINDER	KEYMARK X4	626	MED
1	EA	SURFACE CLOSER	4040XP SCUSH	689	LCN
1	EA	KICK PLATE	KO050 10" X 2" LDW	630	TRM
1	SET	SEAL	BY STC DOOR MFR		
1	SET	DOOR BOTTOM	BY STC DOOR MFR		
CARD READER - WORK OF DIVISION 28					
POWER SUPPLY - WORK OF DIVISION 28					

GROUP NO. 12

2	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	ELECTRIC HINGE	5BB1 4.5 X 4.5 TW8	652	IVE
1	EA	EU MORTISE LOCK	L9092HDEU 06L RX CON 12/24 VDC	626	SCH
1	EA	SFIC CYLINDER	KEYMARK X4	626	MED
1	EA	SURFACE CLOSER	4040XP	689	LCN
1	EA	KICK PLATE	KO050 10" X 2" LDW	630	TRM
1	EA	WALL STOP	1270WX	626	TRM
1	SET	SEAL	BY STC DOOR MFR		
1	SET	DOOR BOTTOM	BY STC DOOR MFR		
			CARD READER - WORK OF DIVISION 28		
			POWER SUPPLY - WORK OF DIVISION 28		

GROUP NO. 13

2	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	ELECTRIC HINGE	5BB1 4.5 X 4.5 TW8	652	IVE
1	EA	EU STOREROOM LOCK	ND80HDEU RHO RX CON 12V/24V DC	626	SCH
1	EA	SFIC CYLINDER	KEYMARK X4	626	MED
1	EA	SURFACE CLOSER	4040XP	689	LCN
1	EA	WALL STOP	1270WX	626	TRM
1	SET	SEAL	BY STC DOOR MFR		
1	SET	DOOR BOTTOM	BY STC DOOR MFR		
			CARD READER - WORK OF DIVISION 28		
			POWER SUPPLY - WORK OF DIVISION 28		

GROUP NO. 14

2	EA	HINGE	5BB1HW 4.5 X 4.5	652	IVE
1	EA	ELECTRIC HINGE	5BB1HW 4.5 X 4.5 TW8	652	IVE
1	EA	EU MORTISE LOCK	L9092HDEU 06L RX CON 12/24 VDC	626	SCH
1	EA	SFIC CYLINDER	KEYMARK X4	626	MED
1	EA	OH STOP	100S	630	GLY
1	EA	SURFACE CLOSER	4040XP ST-1630	689	LCN
1	EA	KICK PLATE	KO050 10" X 2" LDW	630	TRM
1	SET	SEAL	BY STC DOOR MFR		
1	SET	DOOR BOTTOM	BY STC DOOR MFR		
1	EA	VIEWER	U698	626	IVE
			CARD READER - WORK OF DIVISION 28		
			POWER SUPPLY - WORK OF DIVISION 28		

GROUP NO. 15

2	EA	HINGE	5BB1HW 4.5 X 4.5	652	IVE
1	EA	ELECTRIC HINGE	5BB1HW 4.5 X 4.5 TW8	652	IVE
1	EA	EU MORTISE LOCK	L9092HDEU 06L RX CON 12/24 VDC	626	SCH
1	EA	SFIC CYLINDER	KEYMARK X4	626	MED
1	EA	SURFACE CLOSER	1461 FC	689	LCN
1	EA	KICK PLATE	KO050 10" X 2" LDW	630	TRM
1	EA	WALL STOP	1270WX	626	TRM
1	SET	SEAL	BY STC DOOR MFR		
1	SET	DOOR BOTTOM	BY STC DOOR MFR		
			CARD READER - WORK OF DIVISION 28		
			POWER SUPPLY - WORK OF DIVISION 28		

GROUP NO. 16

2	EA	HINGE	5BB1 - SIZE AND THICKNESS TO MATCH EXISTING	652	IVE
1	EA	ELECTRIC HINGE	5BB1 TW8 - SIZE AND THICKNESS TO MATCH EXISTING	652	IVE
1	EA	EU STOREROOM LOCK	ND80HDEU RHO RX CON 12V/24V DC	626	SCH
1	EA	SFIC CYLINDER	KEYMARK X4	626	MED
1	EA	SURFACE CLOSER	4040XP	689	LCN
1	EA	KICK PLATE	KO050 10" X 2" LDW	630	TRM
1	SET	SEALS	5050B	BRN	NGP
1	EA	DOOR BOTTOM	225N	AL	NGP
1	EA	VIEWER	U698	626	IVE
			CARD READER - WORK OF DIVISION 28		
			POWER SUPPLY - WORK OF DIVISION 28		

GROUP NO. 17

1	EA	CONT. HINGE	112XY EPT	628	IVE
1	EA	POWER TRANSFER	EPT10	689	VON
1	EA	EU MORTISE LOCK	L9092HDEU 06L RX CON 12/24 VDC	626	SCH
1	EA	SFIC CYLINDER	KEYMARK X4	626	MED
1	EA	SURFACE CLOSER	4040XP EDA	689	LCN
1	EA	KICK PLATE	KO050 10" X 2" LDW	630	TRM
1	EA	WALL STOP	1270WX	626	TRM
1	SET	SEALS	5050B	BRN	NGP
			CARD READER - WORK OF DIVISION 28		
			POWER SUPPLY - WORK OF DIVISION 28		

GROUP NO. 18

3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	STOREROOM LOCK	L9080HD 06L	626	SCH
1	EA	SFIC CYLINDER	KEYMARK X4	626	MED
1	EA	SURFACE CLOSER	4040XP	689	LCN
1	EA	KICK PLATE	KO050 10" X 2" LDW	630	TRM
1	EA	FLOOR STOP	1211	626	TRM
3	EA	SILENCER	SR64	GRY	IVE

GROUP NO. 19

3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	PRIVACY LOCK	L9040 06L L583-363	626	SCH
1	EA	SURFACE CLOSER	4040XP	689	LCN
1	EA	KICK PLATE	KO050 10" X 2" LDW	630	TRM
1	EA	MOP PLATE	KO050 6" X 2" LDW	630	TRM
1	EA	FLOOR STOP	1211	626	TRM
1	SET	SEALS	5050B	BRN	NGP

GROUP NO. 20

3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	PRIVACY LOCK W/ OUTSIDE INDICATOR	ND40S RHO OS-OCC	626	SCH
1	EA	SURFACE CLOSER	4040XP	689	LCN
1	EA	KICK PLATE	KO050 10" X 2" LDW	630	TRM
1	EA	MOP PLATE	KO050 6" X 2" LDW	630	TRM
1	EA	FLOOR STOP	1211	626	TRM
1	SET	SEALS	5050B	BRN	NGP

GROUP NO. 21

1	EA	SURFACE CLOSER	4040XP	689	LCN
			BALANCE OF HARDWARE EXISTING TO REMAIN		

GROUP NO. 22

1	EA	KICK PLATE	KO050 10" X 2" LDW	630	TRM
1	EA	MOP PLATE	KO050 6" X 2" LDW	630	TRM
			BALANCE OF HARDWARE		
			EXISTING TO REMAIN		

GROUP NO. 23

1	EA	STOREROOM LOCK	ND80HD RHO	626	SCH
1	EA	SFIC CYLINDER	KEYMARK X4	626	MED
1	EA	ELECTRIC STRIKE	1006	630	HES
1	EA	SURFACE CLOSER	1461 FC	689	LCN
1	SET	SEALS	5050B	BRN	NGP
1	EA	DOOR BOTTOM	225N	AL	NGP
			CARD READER - WORK OF		
			DIVISION 28		
			POWER SUPPLY - WORK OF		
			DIVISION 28		
			BALANCE OF HARDWARE		
			EXISTING TO REMAIN		

GROUP NO. 24

3	EA	HINGE	5BB1 - SIZE AND THICKNESS TO MATCH EXISTING	652	IVE
1	EA	STOREROOM LOCK	ND80HD RHO	626	SCH
1	EA	SFIC CYLINDER	KEYMARK X4	626	MED
1	EA	ELECTRIC STRIKE	1006	630	HES
1	EA	SURFACE CLOSER	4040XP	689	LCN
1	EA	WALL STOP	1270WX	626	TRM
1	SET	SEALS	5050B	BRN	NGP
1	EA	DOOR BOTTOM	225N	AL	NGP
1	EA	VIEWER	U698	626	IVE
			CARD READER - WORK OF		
			DIVISION 28		
			POWER SUPPLY - WORK OF		
			DIVISION 28		

GROUP NO. 25

3	EA	HINGE	5BB1 - SIZE AND THICKNESS TO MATCH EXISTING	652	IVE
1	EA	STOREROOM LOCK	ND80HD RHO	626	SCH
1	EA	SFIC CYLINDER	KEYMARK X4	626	MED
1	EA	ELECTRIC STRIKE	1006	630	HES
1	EA	SURFACE CLOSER	4040XP	689	LCN
1	EA	KICK PLATE	KO050 10" X 2" LDW	630	TRM
1	EA	FLOOR STOP	1211	626	TRM
			CARD READER - WORK OF DIVISION 28		
			POWER SUPPLY - WORK OF DIVISION 28		

GROUP NO. 26

1	EA	STOREROOM LOCK	L9080HD 06L	626	SCH
1	EA	SFIC CYLINDER	KEYMARK X4	626	MED
1	EA	ELECTRIC STRIKE	1006	630	HES
			CARD READER - WORK OF DIVISION 28		
			POWER SUPPLY - WORK OF DIVISION 28		
			BALANCE OF HARDWARE EXISTING TO REMAIN		

PROVIDE WRAP AROUND PLATE AS REQUIRED TO COVER PREP FROM EXISTING PANIC
HARDWARE AND CYPHER LOCK.

GROUP NO. 27

1	EA	ELECTRIC STRIKE	1006	630	HES
			CARD READER - WORK OF DIVISION 28		
			POWER SUPPLY - WORK OF DIVISION 28		
			BALANCE OF HARDWARE EXISTING TO REMAIN		

GROUP NO. 28

1	EA	SURF. AUTO OPERATOR	9542IQ TLS LESS TRACK COV RSA	628	LCN
2	EA	ACTUATOR, TOUCH	8310-856T BALANCE OF HARDWARE EXISTING TO REMAIN		LCN

GROUP NO. 29

3	EA	HINGE	5BB1 - SIZE AND THICKNESS TO MATCH EXISTING	652	IVE
1	EA	PASSAGE SET	ND10S RHO	626	SCH
1	EA	SFIC CYLINDER	KEYMARK X4	626	MED
1	EA	ELECTRIC STRIKE	1006	630	HES
1	EA	SURF. AUTO OPERATOR	9542IQ TLS LESS TRACK COV RSA	628	LCN
2	EA	ACTUATOR, TOUCH	8310-856T		LCN
1	EA	KICK PLATE	KO050 10" X 2" LDW	630	TRM
1	EA	WALL STOP	1270WX	626	TRM
1	EA	VIEWER	U698 CARD READER - WORK OF DIVISION 28	626	IVE

GROUP NO. 30

3	EA	HINGE	5BB1 - SIZE AND THICKNESS TO MATCH EXISTING	652	IVE
1	EA	STOREROOM LOCK	ND80HD RHO	626	SCH
1	EA	SFIC CYLINDER	KEYMARK X4	626	MED
1	EA	ELECTRIC STRIKE	1006	630	HES
1	EA	SURF. AUTO OPERATOR	9531IQ COV RSA	628	LCN
1	EA	ACTUATOR, TOUCH	8310-856T		LCN
1	EA	KICK PLATE	KO050 10" X 2" LDW	630	TRM
1	EA	WALL STOP	1270WX	626	TRM
1	SET	SEALS	5050B	BRN	NGP
1	EA	DOOR BOTTOM	225N CARD READER - WORK OF DIVISION 28 POWER SUPPLY - WORK OF DIVISION 28	AL	NGP

GROUP NO. 31

1	EA	OFFICE W/SIM RETRACT	L9056HD 06L 09-544	626	SCH
1	EA	SFIC CYLINDER	KEYMARK X4	626	MED
			BALANCE OF HARDWARE		
			EXISTING TO REMAIN		

PROVIDE WRAP AROUND PLATE AS REQUIRED TO COVER PREP FROM EXISTING PANIC
HARDWARE AND CYPHER LOCK.

GROUP NO. 32

6	EA	HINGE	5BB1HW 4.5 X 4.5	652	IVE
2	EA	POWER TRANSFER	EPT10	689	VON
1	EA	ELEC PANIC HARDWARE	RX-QEL-9847WDC-L-DT-LBR-06- SNB 24 VDC	626	VON
1	EA	ELEC PANIC HARDWARE	RX-QEL-9847WDC-L-NL-LBR-06- SNB 24 VDC	626	VON
1	EA	SFIC RIM CYLINDER	KEYMARK X4	626	MED
1	EA	SURFACE CLOSER	4040XP EDA	689	LCN
1	EA	SURFACE CLOSER	4040XP SCUSH	689	LCN
2	EA	KICK PLATE	KO050 10" X 2" LDW	630	TRM
2	EA	WALL STOP	1270WX	626	TRM
1	SET	SEAL	BY STC DOOR MFR		
1	SET	MEETING STILE	BY STC DOOR MFR		
2	SET	DOOR BOTTOM	BY STC DOOR MFR		
			CARD READER - WORK OF DIVISION 28		
			POWER SUPPLY - WORK OF DIVISION 28		

GROUP NO. 33

6	EA	HINGE	5BB1HW 4.5 X 4.5	652	IVE
2	EA	PANIC HARDWARE	9847WDC-L-BE-06-SNB	626	VON
2	EA	SURFACE CLOSER	4040XP EDA	689	LCN
2	EA	KICK PLATE	KO050 10" X 2" LDW	630	TRM
2	EA	FLOOR STOP	1211	626	TRM
1	SET	MEETING STILE	137SA	CL	NGP
1	SET	SEALS	5050B	BRN	NGP

GROUP NO. 34

6	EA	HINGE	5BB1HW 4.5 X 4.5	652	IVE
2	EA	PUSH PLATE	8200 6" X 16"	630	IVE
2	EA	PULL PLATE	8302 10" 6" X 16"	630	IVE
2	EA	SURFACE CLOSER	4040XP EDA	689	LCN
2	EA	KICK PLATE	KO050 10" X 2" LDW	630	TRM
2	EA	WALL STOP	1270WX	626	TRM
1	SET	SEAL	BY STC DOOR MFR		
1	SET	MEETING STILE	BY STC DOOR MFR		
2	SET	DOOR BOTTOM	BY STC DOOR MFR		

GROUP NO. 35

1	SET	BI PASS DOOR HARDWARE	134F	AL	JOH
2	EA	FLUSH PULL	227	626	IVE

END OF SECTION

**SECTION 08 80 00
GLAZING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Insulating glass units.
- B. Glazing units, glass for non-rated windows and doors.
- C. Plastic films.
- D. Glazing compounds.

1.02 RELATED REQUIREMENTS

- A. Section 07 27 00 - Air Barriers.
- B. Section 08 14 16 - Flush Wood Doors: Glazed lites in doors.
- C. Section 08 43 13 - Aluminum-Framed Storefronts: Glazing provided as part of storefront assembly.
- D. Section 08 53 13 - Vinyl Windows: Glazing provided by window manufacturer.

1.03 REFERENCE STANDARDS

- A. 16 CFR 1201 - Safety Standard for Architectural Glazing Materials; Current Edition.
- B. ANSI Z97.1 - American National Standard for Safety Glazing Materials Used in Buildings - Safety Performance Specifications and Methods of Test; 2015 (Reaffirmed 2020).
- C. ASTM C864 - Standard Specification for Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers; 2005 (Reapproved 2019).
- D. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; 2018.
- E. ASTM C1036 - Standard Specification for Flat Glass; 2025.
- F. ASTM C1048 - Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass; 2025.
- G. ASTM C1193 - Standard Guide for Use of Joint Sealants; 2025.
- H. ASTM C1376 - Standard Specification for Pyrolytic and Vacuum Deposition Coatings on Flat Glass; 2021a.
- I. ASTM E1300 - Standard Practice for Determining Load Resistance of Glass in Buildings; 2024.
- J. ASTM E2190 - Standard Specification for Insulating Glass Unit Performance and Evaluation; 2019.
- K. GANA (GM) - GANA Glazing Manual; 2022.
- L. GANA (SM) - GANA Sealant Manual; 2008.
- M. GANA (LGRM) - Laminated Glazing Reference Manual; 2019.
- N. IGMA TM-3000 - North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial & Residential Use; 1990 (Reaffirmed 2016).
- O. NFRC 100 - Procedure for Determining Fenestration Product U-factors; 2023.
- P. NFRC 200 - Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence; 2023.
- Q. NFRC 300 - Test Method for Determining the Solar Optical Properties of Glazing Materials and Systems; 2023.

1.04 SUBMITTALS

- A. Product Data on Glazing Unit Glazing Types: Provide structural, physical and environmental characteristics, size limitations, special handling and installation requirements.
- B. Product Data on Glazing Compounds and Accessories: Provide chemical, functional, and environmental characteristics, limitations, special application requirements, and identify available colors.
- C. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.05 QUALITY ASSURANCE

- A. Perform Work in accordance with GANA (GM), GANA (SM), GANA (LGRM), and IGMA TM-3000 for glazing installation methods. Maintain one copy on site.
- B. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years documented experience.

1.06 FIELD CONDITIONS

- A. Do not install glazing when ambient temperature is less than 40 degrees F (4 degrees C).
- B. Maintain minimum ambient temperature before, during and 24 hours after installation of glazing compounds.

1.07 WARRANTY

- A. Insulating Glass Units: Provide a five (5) year manufacturer warranty to include coverage for seal failure, interpane dusting or misting, including providing products to replace failed units.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Float Glass Manufacturers:
 - 1. Guardian Glass, LLC: www.guardianglass.com/#sle.
 - 2. Pilkington North America Inc: www.pilkington.com/na/#sle.
 - 3. Saint Gobain North America: www.saint-gobain.com/#sle.
 - 4. Vitro Architectural Glass (formerly PPG Glass): www.vitroglazings.com/#sle.

2.02 PERFORMANCE REQUIREMENTS - EXTERIOR GLAZING ASSEMBLIES

- A. Provide type and thickness of exterior glazing assemblies to support assembly dead loads, and to withstand live loads caused by positive and negative wind pressure acting normal to plane of glass.
 - 1. Comply with ASTM E1300 for design load resistance of glass type, thickness, dimensions, and maximum lateral deflection of supported glass.
 - 2. Provide glass edge support system sufficiently stiff to limit the lateral deflection of supported glass edges to less than 1/175 of their lengths under specified design load.
 - 3. Glass thicknesses listed are minimum.
- B. Weather-Resistive Barrier Seals: Provide completed assemblies that maintain continuity of building enclosure water-resistive barrier, vapor retarder, and/or air barrier.
 - 1. In conjunction with weather barrier related materials described in other sections, as follows:
 - a. Air Barriers: See Section 07 27 00.
- C. Thermal and Optical Performance: Provide exterior glazing products with performance properties as indicated. Performance properties are in accordance with manufacturer's published data as determined with the following procedures and/or test methods:
 - 1. Center of Glass U-Value: Comply with NFRC 100 using Lawrence Berkeley National Laboratory (LBNL) WINDOW 6.3 computer program.
 - 2. Center of Glass Solar Heat Gain Coefficient (SHGC): Comply with NFRC 200 using Lawrence Berkeley National Laboratory (LBNL) WINDOW 6.3 computer program.

3. Solar Optical Properties: Comply with NFRC 300 test method.

2.03 GLASS MATERIALS

- A. Float Glass: Provide float glass based glazing unless otherwise indicated.
 1. Annealed Type: ASTM C1036, Type I - Transparent Flat, Class 1 - Clear, Quality - Q3.
 2. Kind HS - Heat-Strengthened Type: Complies with ASTM C1048.
 3. Kind FT - Fully Tempered Type: Complies with ASTM C1048.
 4. Fully Tempered Safety Glass: Complies with ANSI Z97.1 or 16 CFR 1201 criteria for safety glazing used in hazardous locations.

2.04 INSULATING GLASS UNITS

- A. Manufacturers:
 1. Basis of Design: Vitro Architectural Glass (formerly PPG Glass); Solarban 60 (2) Solarblue + Clear: www.vitroglazings.com/#sle or an equal product by one of the following:
 2. Guardian Glass, LLC: www.guardianglass.com/#sle.
 3. Pilkington North America Inc: www.pilkington.com/na/#sle.Pilkington North America Inc: www.pilkington.com/na/#sle.
 4. Viracon, Apogee Enterprises, Inc: www.viracon.com/#sle.
- B. Insulating Glass Units: Types as indicated.
 1. Durability: Certified by an independent testing agency to comply with ASTM E2190.
 2. Coated Glass: Comply with requirements of ASTM C1376 for pyrolytic (hard-coat) or magnetic sputter vapor deposition (soft-coat) type coatings on flat glass; coated vision glass, Kind CV; coated overhead glass, Kind CO; or coated spandrel glass, Kind CS.
 3. Spacer Color: Black.
 4. Purge interpane space with dry air, hermetically sealed.
- C. Insulating Glass Units: Vision glass, double glazed.
 1. Applications: Exterior glazing unless otherwise indicated.
 2. Space between lites filled with air.
 3. Outboard Lite: Annealed float glass, 1/4 inch (6.4 mm) thick, minimum.
 - a. Tint: Blue.
 - b. Coating: Low-E (passive type), on #2 surface.
 4. Inboard Lite: Annealed float glass, 1/4 inch (6.4 mm) thick, minimum.
 - a. Tint: Clear.
 5. Total Thickness: 1 inch (25.4 mm).
 6. Thermal Transmittance (U-Value), Winter - Center of Glass: 0.29, nominal.
 7. Visible Light Transmittance (VLT): 45 percent, nominal.
 8. Solar Heat Gain Coefficient (SHGC): 0.29, nominal.

2.05 PLASTIC FILMS

- A. Mirror Film (WF-1):
 1. Application: Locations as indicated on drawings.
 2. Material: PET (Polyethylene) film with metallized particles that create a mirrored effect.
 3. Thickness Without Liner: 2 mil.
 4. Size: 60 inch by 100 foot rolls.
 5. Basis of Design: 3M Window Films; Mirror Film, solutions.3m.com/wps/portal/3M/en_US/Window_Film/Solutions/#sle.
- B. Privacy Film (WF-2): Frosted:
 1. Application: Locations as indicated on drawings.
 2. Material: Vinyl with pressure-sensitive adhesive.
 3. Thickness : 4.7 mil.
 4. Size: 48 or 60 inch by 150 foot rolls.
 5. Visible Light Transmission 72%.

6. Basis of Design: 3M Frosted Crystal White 7725SE-324.
- C. Safety and Security (WF-3): Static cling type, Refer to drawings for manufacturer, Match existing.

2.06 GLAZING COMPOUNDS

- A. Polyurethane Sealant: Single component, chemical curing, nonstaining, nonbleeding; ASTM C920 Type S, Grade NS, Class 25, Uses M, A, and G; with cured Shore A hardness range of 20 to 35; color as selected.
- B. Silicone Sealant: Single component; neutral neutral curing; capable of water immersion without loss of properties; nonbleeding, nonstaining; ASTM C920 Type S, Grade NS, Class 25, Uses M, A, and G; ; ASTM C920 Type S, Grade NS, Class 25, Uses M, A, and G; with cured Shore A hardness range of 15 to 25 15 to 25; color as selected color as selected.

2.07 ACCESSORIES

- A. Setting Blocks: Silicone, with 80 to 90 Shore A durometer hardness; ASTM C864 Option II. Length of 0.1 inch for each square foot (25 mm for each square meter) of glazing or minimum 4 inch (100 mm) by width of glazing rabbet space minus 1/16 inch (1.5 mm) by height to suit glazing method and pane weight and area.
- B. Glazing Tape, Back Bedding Mastic Type: Preformed, butyl-based, 100 percent solids compound with integral resilient spacer rod applicable to application indicated; 5 to 30 cured Shore A durometer hardness; coiled on release paper; black color.
1. Width: As required for application.
 2. Thickness: As required for application.
 3. Spacer Rod Diameter: As required for application.

PART 3 EXECUTION

3.01 VERIFICATION OF CONDITIONS

- A. Verify that openings for glazing are correctly sized and within tolerances, including those for size, squareness, and offsets at corners.
- B. Verify that surfaces of glazing channels or recesses are clean, free of obstructions that may impede moisture movement, weeps are clear, and support framing is ready to receive glazing system.

3.02 INSTALLATION, GENERAL

- A. Install glazing sealants in accordance with ASTM C1193, GANA (SM), and manufacturer's instructions.

3.03 INSTALLATION - WET/DRY GLAZING METHOD (TAPE AND SEALANT)

- A. Application - Interior Glazed: Set glazing infills from the interior of the building.
- B. Cut glazing tape to length and install against permanent stops, projecting 1/16 inch (1.6 mm) above sight line.
- C. Place setting blocks at 1/4 points with edge block no more than 6 inch (152 mm) from corners.
- D. Rest glazing on setting blocks and push against tape to ensure full contact at perimeter of pane or unit.
- E. Install removable stops, spacer shims inserted between glazing and applied stops at 24 inch (610 mm) intervals, 1/4 inch (6 mm) below sight line.
- F. Fill gaps between pane and applied stop with sealant to depth equal to bite on glazing, to uniform and level line.
- G. Carefully trim protruding tape with knife.

3.04 INSTALLATION - PLASTIC FILM

- A. Install plastic film with adhesive, applied in accordance with film manufacturer's instructions.

- B. Place without air bubbles, creases or visible distortion.
- C. Install film tight to perimeter of glass and carefully trim film with razor sharp knife. Provide 1/16 inch (1.6 mm) to 1/8 inch (3.2 mm) gap at perimeter of glazed panel unless otherwise required. Do not score the glass.

3.05 FIELD QUALITY CONTROL

- A. Glass and Glazing product manufacturers to provide field surveillance of the installation of their products.
- B. Monitor and report installation procedures and unacceptable conditions.

3.06 CLEANING

- A. Remove excess glazing materials from finish surfaces immediately after application using solvents or cleaners recommended by manufacturers.
- B. Remove nonpermanent labels immediately after glazing installation is complete.
- C. Clean glass and adjacent surfaces after sealants are fully cured.
- D. Clean glass on both exposed surfaces not more than 4 days prior to Date of Substantial Completion in accordance with glass manufacturer's written recommendations.

3.07 PROTECTION

- A. After installation, mark pane with an 'X' by using removable plastic tape or paste.
- B. Remove and replace glass that is damaged during construction period prior to Date of Substantial Completion.

END OF SECTION

**SECTION 09 05 61
COMMON WORK RESULTS FOR FLOORING PREPARATION**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. This section applies to floors identified in Contract Documents that are receiving the following types of floor coverings:
 - 1. Resilient sheet.
 - 2. Carpet tile.
 - 3. Thin-set ceramic tile and porcelain tile.
- B. Preparation of existing concrete floor slabs for installation of floor coverings.
- C. Testing of concrete floor slabs for moisture and alkalinity (pH).
- D. Testing of existing concrete floor slabs for moisture and alkalinity (pH) has already been conducted; test report is attached.
- E. Remediation of concrete floor slabs due to unsatisfactory moisture or alkalinity (pH) conditions.
 - 1. Contractor shall perform all specified remediation of concrete floor slabs. If such remediation is indicated by testing agency's report and is due to a condition not under Contractor's control or could not have been predicted by examination prior to entering into the contract, a contract modification will be issued.
- F. Remedial floor coatings.

1.02 REFERENCE STANDARDS

- A. ASTM F1869 - Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride; 2023.

1.03 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Floor Covering and Adhesive Manufacturers' Product Literature: For each specific combination of substrate, floor covering, and adhesive to be used; showing:
 - 1. Moisture and alkalinity (pH) limits and test methods.
 - 2. Manufacturer's required bond/compatibility test procedure.
- C. Remedial Materials Product Data: Manufacturer's published data on each product to be used for remediation.
- D. Testing Agency's Report:
 - 1. Description of areas tested; include floor plans and photographs if helpful.
 - 2. Summary of conditions encountered.
 - 3. Moisture and alkalinity (pH) test reports.
 - 4. Copies of specified test methods.
 - 5. Recommendations for remediation of unsatisfactory surfaces.
 - 6. Submit report directly to Owner.
 - 7. Submit report not more than two business days after conclusion of testing.
- E. Adhesive Bond and Compatibility Test Report.

1.04 QUALITY ASSURANCE

- A. Moisture and alkalinity (pH) testing will be performed by an independent testing agency employed and paid by Owner.
- B. Testing Agency Qualifications: Independent testing agency experienced in the types of testing specified.
 - 1. Submit evidence of experience consisting of at least 3 test reports of the type required, with project Owner's project contact information.

- C. Contractor's Responsibility Relating to Independent Agency Testing:
 - 1. Provide access for and cooperate with testing agency.
 - 2. Confirm date of start of testing at least 10 days prior to actual start.
 - 3. Allow at least 4 business days on site for testing agency activities.
 - 4. Achieve and maintain specified ambient conditions.
 - 5. Notify Owner when specified ambient conditions have been achieved and when testing will start.
- D. Remedial Coating Installer Qualifications: Company specializing in performing work of the type specified in this section, trained by or employed by coating manufacturer.

1.05 FIELD CONDITIONS

- A. Maintain ambient temperature in spaces where concrete testing is being performed, and for at least 48 hours prior to testing, at not less than 65 degrees F (18 degrees C) or more than 85 degrees F (30 degrees C).
- B. Maintain relative humidity in spaces where concrete testing is being performed, and for at least 48 hours prior to testing, at not less than 40 percent and not more than 60 percent.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Remedial Floor Coating: Single- or multi-layer coating or coating/overlay combination intended by its manufacturer to resist water vapor transmission to degree sufficient to meet flooring manufacturer's emission limits, resistant to the level of alkalinity (pH) found, and suitable for adhesion of flooring without further treatment.
 - 1. Thickness: As required for application and in accordance with manufacturer's installation instructions.
 - 2. Basis -of-Design Product:
 - a. UZIN UTZ NORTH AMERICA, INC; UZIN PE 460 with UZIN PE 280 and UZIN NC 170 LevelStar: <https://us.uzin.com/#sle>.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.

PART 3 EXECUTION

3.01 CONCRETE SLAB PREPARATION

- A. Perform following operations in the order indicated:
 - 1. Preliminary cleaning.
 - 2. Moisture vapor emission tests; 3 tests in the first 1000 square feet (100 square meters) and one test in each additional 1000 square feet (100 square meters), unless otherwise indicated or required by flooring manufacturer.
 - 3. Internal relative humidity tests; in same locations as moisture vapor emission tests, unless otherwise indicated.
 - 4. Alkalinity (pH) tests; in same locations as moisture vapor emission tests, unless otherwise indicated.
 - 5. Specified remediation, if required.
 - 6. Patching, smoothing, and leveling, as required.
 - 7. Other preparation specified.
 - 8. Adhesive bond and compatibility test.
 - 9. Protection.

3.02 MOISTURE VAPOR EMISSION TESTING

- A. Where the floor covering manufacturer's requirements conflict with either the referenced test method or this specification, comply with the manufacturer's requirements.
- B. Where this specification conflicts with the referenced test method, comply with the requirements of this section.

- C. Test in accordance with ASTM F1869 and as follows.
- D. Plastic sheet test and mat bond test may not be substituted for the specified ASTM test method, as those methods do not quantify the moisture content sufficiently.
- E. In the event that test values exceed floor covering manufacturer's limits, perform remediation as indicated. In the absence of manufacturer limits, perform remediation if test values exceed 3 pounds per 1000 square feet (1.4 kg per 93 square meters) per 24 hours.
- F. Report: Report the information required by the test method.

3.03 ALKALINITY TESTING

- A. Where the floor covering manufacturer's requirements conflict with either the referenced test method or this specification, comply with the manufacturer's requirements.
- B. In the event that test values exceed floor covering manufacturer's limits, perform remediation as indicated. In the absence of manufacturer limits, perform remediation if alkalinity (pH) test value is over 10.

3.04 ADHESIVE BOND AND COMPATIBILITY TESTING

- A. Comply with requirements and recommendations of floor covering manufacturer.

3.05 APPLICATION OF REMEDIAL FLOOR COATING

- A. Comply with requirements and recommendations of coating manufacturer.

END OF SECTION

**SECTION 09 21 16
GYPSUM BOARD ASSEMBLIES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Performance criteria for gypsum board assemblies.
- B. Grid suspension system.
- C. Cementitious backing board.
- D. Gypsum wallboard.
- E. Joint treatment and accessories.
- F. Acoustic (sound-dampening) wall and ceiling board.

1.02 RELATED REQUIREMENTS

- A. Section 07 21 00 - Thermal Insulation: Acoustic insulation.
- B. Section 07 84 00 - Firestopping: Top-of-wall assemblies at fire-resistance-rated walls.
- C. Section 07 92 00 - Joint Sealants: Sealing acoustical gaps in construction other than gypsum board or plaster work.
- D. Section 09 22 16 - Non-Structural Metal Framing.

1.03 REFERENCE STANDARDS

- A. ANSI A108.11 - American National Standard Specifications for Interior Installation of Cementitious Backer Units; 2023.
- B. ANSI A118.9 - American National Standard Specifications for Test Methods and Specifications for Cementitious Backer Units; 2023.
- C. ASTM C475/C475M - Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board; 2017 (Reapproved 2022).
- D. ASTM C840 - Standard Specification for Application and Finishing of Gypsum Board; 2024.
- E. ASTM C954 - 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; 2022.
- F. ASTM C1047 - Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base; 2019.
- G. ASTM C1325 - Standard Specification for Fiber-Mat Reinforced Cementitious Backer Units; 2022, with Editorial Revision (2023).
- H. ASTM C1396/C1396M - Standard Specification for Gypsum Board; 2024.
- I. ASTM D3273 - Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber; 2021.
- J. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements; 2023.
- K. ASTM E413 - Classification for Rating Sound Insulation; 2022.
- L. GA-216 - Application and Finishing of Gypsum Panel Products; 2024.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate the installation of gypsum board assemblies with size, location, and installation of service utilities.

1.05 SUBMITTALS

- A. Product Data:

1. Provide data on gypsum board, accessories, and joint finishing system.

1.06 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Store gypsum products and accessories indoors and keep above freezing. Elevate boards above floor, on nonwicking supports, in accordance with manufacturer's recommendations.
- B. Store metal products to prevent corrosion.

PART 2 PRODUCTS

2.01 GYPSUM BOARD ASSEMBLIES

- A. Provide completed assemblies complying with ASTM C840 and GA-216.
 1. See PART 3 for finishing requirements.
- B. Interior Partitions: Provide completed assemblies as indicated on the drawings.
- C. Grid Suspension Systems: Provide grid suspension systems in accordance with ASTM C840 and GA-216 complying with the following:
- D. Fire-Resistance-Rated Assemblies: Provide completed assemblies as indicated on the Drawings.

2.02 METAL FRAMING MATERIALS

- A. Grid Suspension Systems: Steel grid system of main tees and support bars connected to structure using hanging wire.
 1. Products:
 - a. USG Corporation; Drywall Suspension System: www.usg.com/#sle.
 - b. Armstrong World Industries, Inc.; "Drywall Grid Systems."
 - c. Chicago Metallic Corporation; "Drywall Grid System."

2.03 BOARD MATERIALS

- A. Manufacturers - Gypsum-Based Board:
 1. American Gypsum Company: www.americangypsum.com/#sle.
 2. CertainTeed Corporation: www.certainteed.com/#sle.
 3. Georgia-Pacific Gypsum: www.gpgypsum.com/#sle.
 4. Gold Bond Building Products, LLC provided by National Gypsum Company: www.goldbondbuilding.com/#sle.
 5. PABCO Gypsum: www.pabcogypsum.com/#sle.
 6. USG Corporation: www.usg.com/#sle.
- B. Gypsum Wallboard : Type X paper-faced gypsum panels as defined in ASTM C1396/C1396M; sizes to minimize joints in place; ends square cut; tapered long edges.
 1. Application: Use for vertical surfaces and ceilings, unless otherwise indicated.
 2. At Assemblies Indicated with Fire-Resistance Rating: Use type required by indicated tested assembly; if no tested assembly is indicated, use Type X board, UL or WH listed.
 3. Thickness:
 - a. Vertical Surfaces: 5/8 inch (16 mm).
 - b. Ceilings: 1/2 inch (13 mm).
 4. Mold-Resistant, Paper-Faced Products:
 - a. CertainTeed Corporation; M2Tech 5/8" Type X Moisture & Mold Resistant Drywall: www.certainteed.com/#sle.
 - b. Georgia-Pacific Gypsum; ToughRock Fireguard X Mold-Guard: www.gpgypsum.com/#sle.

- c. Gold Bond Building Products, LLC provided by National Gypsum Company; Gold Bond XP Fire-Shield Gypsum Board: www.goldbondbuilding.com/#sle.
- d. USG Corporation; Sheetrock Brand Mold Tough Firecode SCX Panels 5/8 in. (15.9 mm): www.usg.com/#sle.
- C. Tile Backing Board: One of the following products:
 - 1. Application: Surfaces behind tile in wet areas as indicated on the drawings.
 - 2. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
 - 3. ANSI Cement-Based Board: Non-gypsum-based; aggregated Portland cement panels with glass fiber mesh embedded in front and back surfaces complying with ANSI A118.9 or ASTM C1325.
 - a. Thickness: 1/2 inch (13 mm).
 - b. Products:
 - 1) Custom Building Products; Wonderboard: www.custombuildingproducts.com/#sle.
 - 2) PermaBASE Building Products, LLC provided by National Gypsum Company; PermaBase Cement Board: www.goldbondbuilding.com/#sle.
 - 3) USG Corporation; Durock: www.usg.com/#sle.
- D. Ceiling Board: Special sag resistant gypsum ceiling board as defined in ASTM C1396/C1396M; sizes to minimize joints in place; ends square cut.
 - 1. Application: Ceilings, unless otherwise indicated.
 - 2. Thickness: 1/2 inch (13 mm).
 - 3. Edges: Tapered.
- E. Acoustical Sound Dampening Wall and Ceiling Board (GYP BD-26): Two layers of heavy paper-faced, high-density gypsum board separated by a viscoelastic polymer layer and capable of achieving STC rating of 54 or more in typical stud wall assemblies as calculated in accordance with ASTM E413 and when tested in accordance with ASTM E90.
 - 1. Thickness: 5/8 inch (16 mm).
 - 2. Long Edges: Tapered.
 - 3. Products:
 - a. CertainTeed Corporation; SilentFX Quick Cut Type X Gypsum Board: www.certainteed.com/#sle.
 - b. Gold Bond Building Products, LLC provided by National Gypsum Company; Gold Bond SoundBreak XP Wall Board: www.goldbondbuilding.com/#sle.
 - c. PABCO Gypsum; QuietRock ES.
 - d. Supress Products, LLC.; Supress SED5848.
- F. Shaftwall and Coreboard: Type X; 1 inch (25 mm) thick by 24 inches (600 mm) wide, beveled long edges, ends square cut.
 - 1. Paper-Faced Type: Gypsum shaftliner board or gypsum coreboard as defined ASTM C1396/C1396M; water-resistant faces.
 - 2. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
 - 3. Paper-Faced Products:
 - a. CertainTeed Corporation; M2Tech Type X Shaftliner: www.certainteed.com/#sle.
 - b. Gold Bond Building Products, LLC provided by National Gypsum Company; Gold Bond Shaftliner XP: www.goldbondbuilding.com/#sle.
 - c. USG Corporation; Sheetrock Brand Mold Tough Gypsum Liner Panels 1 in. (25.4 mm) SLX: www.usg.com/#sle.

2.04 GYPSUM BOARD ACCESSORIES

- A. Acoustic Insulation: See Section 07 21 00.
- B. Acoustic Sealant: Acrylic emulsion latex or water-based elastomeric sealant; do not use solvent-based non-curing butyl sealant; see Section 07 92 00.

- C. Finishing Accessories: ASTM C1047, extruded aluminum alloy (6063 T5) or galvanized steel sheet ASTM A924/A924M G90, unless noted otherwise.
 - 1. Types: As detailed or required for finished appearance.
 - 2. Products:
 - a. Phillips Manufacturing Co; Zinc Control Joint No. 093: www.phillipsmfg.com/#sle.
 - b. Trim-tex, Inc; Tear Away L-bead: www.trim-tex.com/#sle.
 - c. USG: Beadex Paper faced Trim B1XW corner reinforcement.
 - d. USG: Beadex Paper faced Trim B4
- D. Joint Materials: ASTM C475/C475M and as recommended by gypsum board manufacturer for project conditions.
- E. Screws for Fastening of Gypsum Panel Products to Steel Members from 0.033 to 0.112 inch (0.84 to 2.84 mm) in Thickness: ASTM C954; steel drill screws, corrosion-resistant.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that project conditions are appropriate for work of this section to commence.

3.02 SHAFT WALL INSTALLATION

- A. Shaft Wall Framing: Install in accordance with manufacturer's installation instructions.
- B. Shaft Wall Liner: Cut panels to accurate dimensions and install sequentially between special friction studs.

3.03 FRAMING INSTALLATION

- A. Suspended Ceilings: Install in accordance with manufacturer's installation instructions.
 - 1. Laterally brace entire suspension system.

3.04 ACOUSTIC ACCESSORIES INSTALLATION

- A. Acoustic Insulation: Place tightly within spaces, around cut openings, behind and around electrical and mechanical items within partitions, and tight to items passing through partitions.
- B. Acoustic Sealant: Install in accordance with manufacturer's instructions.

3.05 BOARD INSTALLATION

- A. Comply with ASTM C840, GA-216, and manufacturer's instructions. Install to minimize butt end joints, especially in highly visible locations.
- B. Fire-Resistance-Rated Construction: Install gypsum board in strict compliance with requirements of assembly listing.
- C. Cementitious Backing Board: Install over steel framing members where indicated, in accordance with ANSI A108.11 and manufacturer's instructions.

3.06 INSTALLATION OF TRIM AND ACCESSORIES

- A. Control Joints: Place control joints consistent with lines of building spaces and as follows:
 - 1. Not more than 30 feet (10 meters) apart on walls and ceilings over 50 feet (16 meters) long.
- B. Corner Beads: Install at external corners, using longest practical lengths.
- C. Edge Trim: Install at locations where gypsum board abuts dissimilar materials.

3.07 JOINT TREATMENT

- A. Glass Mat Faced Gypsum Board: Use fiberglass joint tape, embed and finish with setting type joint compound.
- B. Paper Faced Gypsum Board: Use paper joint tape, embed with drying type joint compound and finish with drying type joint compound.

- C. Finish gypsum board in accordance with levels defined in ASTM C840, as follows:
 - 1. Level 5: Walls and ceilings to receive semi-gloss or gloss paint finish and other areas specifically indicated.
 - 2. Level 4: Walls and ceilings to receive paint finish or wall coverings, unless otherwise indicated.
 - 3. Level 3: Walls to receive textured wall finish.
 - 4. Level 2: In utility areas, behind cabinetry, and on backing board to receive tile finish.
 - 5. Level 1: Fire-resistance-rated wall areas above finished ceilings, whether or not accessible in the completed construction.
- D. Tape, fill, and sand exposed joints, edges, and corners to produce smooth surface ready to receive finishes.
 - 1. Feather coats of joint compound so that camber is maximum 1/32 inch (0.8 mm).
- E. Where Level 5 finish is indicated, spray apply high build drywall surfacer over entire surface after joints have been properly treated; achieve a flat and tool mark-free finish.

3.08 TOLERANCES

- A. Maximum Variation of Finished Gypsum Board Surface from True Flatness: 1/8 inch in 10 feet (3 mm in 3 m) in any direction.

3.09 CLEANING

- A. See Section 01 73 00 - Execution for cleaning requirements.

3.10 PROTECTION

- A. Protect installed gypsum board assemblies from subsequent construction operations.

END OF SECTION

**SECTION 09 22 16
NON-STRUCTURAL METAL FRAMING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Metal partition framing.
- B. Framing accessories.

1.02 RELATED REQUIREMENTS

- A. Section 07 21 00 - Thermal Insulation: Acoustic insulation.
- B. Section 07 84 00 - Firestopping: Sealing top-of-wall assemblies at fire-resistance-rated walls.
- C. Section 07 92 00 - Joint Sealants: Sealing acoustical gaps in construction other than gypsum board or plaster work.
- D. Section 09 21 16 - Gypsum Board Assemblies: Execution requirements for anchors for attaching work of this section.

1.03 REFERENCE STANDARDS

- A. AISI S100 - North American Specification for the Design of Cold-Formed Steel Structural Members; 2016, with Supplement (2020).
- B. AISI S220 - North American Standard for Cold-Formed Steel Nonstructural Framing; 2020.
- C. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2025.
- D. ASTM C754 - Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products; 2020.
- E. ASTM C1002 - Standard Specification for Steel Self-Piercing Tapping Screws for Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs; 2022.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide manufacturer's data on partition head to structure connectors, showing compliance with requirements.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing the work of this section with minimum five years documented experience and approved by manufacturer.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Metal Framing, Connectors, and Accessories:
 - 1. CEMCO: www.cemcosteel.com/#sle.
 - 2. ClarkDietrich: www.clarkdietrich.com/#sle.
 - 3. MarinoWARE: www.marinoware.com/#sle.
 - 4. SCAFCO Corporation: www.scafco.com/#sle.
 - 5. The Steel Network, Inc: www.SteelNetwork.com/#sle.

2.02 FRAMING MATERIALS

- A. Fire-Resistance-Rated Assemblies: Comply with applicable code and as indicated on drawings.
- B. Non-Loadbearing Framing System Components: AISI S220; sheet steel, of size and properties necessary for the spacing indicated, with maximum deflection of wall framing of L/240 at 5 psf (L/240 at 240 Pa).

1. Studs: C-shaped with flat faces.
 - a. Products:
2. Runners: U-shaped, sized to match studs.
3. Ceiling Channels: C-shaped.
4. Furring: Hat-shaped sections, minimum depth of 7/8 inch (22 mm).
- C. Shaft Wall Studs and Accessories: ASTM C645; galvanized sheet steel, of size and properties necessary to comply with ASTM C754 and specified performance requirements.
- D. Partition Head to Structure Connections: Provide mechanical anchorage devices that accommodate deflection using slotted holes, screws, and anti-friction bushings, preventing rotation of studs while maintaining structural performance of partition.
 1. Structural Performance: Maintain lateral load resistance and vertical movement capacity required by applicable code when evaluated in accordance with AISI S100.
 2. Material: ASTM A653/A653M steel sheet, SS Grade 50.
 3. Provide components UL-listed for use in UL-listed fire-resistance-rated head of partition joint systems indicated on drawings.
- E. Non-Loadbearing Framing Accessories:
 1. Fasteners: ASTM C1002 self-piercing self-tapping screws.
 2. Anchorage Devices: Powder actuated.

2.03 FABRICATION

- A. Fabricate assemblies of framed sections to sizes and profiles required as shown on the Drawings.
- B. Fit, reinforce, and brace framing members to suit design requirements.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that rough-in utilities are in proper location.

3.02 INSTALLATION OF STUD FRAMING

- A. Extend partition framing to structure..
- B. Align and secure top and bottom runners at 24 inches (600 mm) on center UON.
- C. Install studs vertically at spacing indicated on drawings.
- D. Align stud web openings horizontally.
- E. Secure studs to tracks using fastener method. Do not weld.
- F. Install double studs at wall openings, door and window jambs, not more than 2 inches (50 mm) from each side of openings.
- G. Coordinate erection of studs with requirements of door frames; install supports and attachments.
- H. Coordinate installation of bucks, anchors, and blocking with electrical, mechanical, and other work to be placed within or behind stud framing.
- I. Furring: Install at spacing and locations shown on drawings. Lap splices a minimum of 6 inches (150 mm).

3.03 TOLERANCES

- A. Maximum Variation From True Position: 1/8 inch in 10 feet (3 mm in 3 m).
- B. Maximum Variation From Plumb: 1/8 inch in 10 feet (3 mm in 3 m).

END OF SECTION

**SECTION 09 30 00
TILING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Tile for floor applications.
- B. Tile for wall applications.
- C. Tile trim.
- D. Metal trim.
- E. Setting, grout, and accessory materials.

1.02 RELATED REQUIREMENTS

- A. Section 09 05 61 - Common Work Results for Flooring Preparation: Concrete slab moisture and alkalinity testing and remediation procedures.

1.03 REFERENCE STANDARDS

- A. ANSI A108.1a - American National Standard Specifications for Installation of Ceramic Tile in the Wet-Set Method, with Portland Cement Mortar; 2023.
- B. ANSI A108.1b - Installation of Ceramic Tile on a Cured Portland Cement Mortar Setting Bed with Dry-Set, Modified Dry-Set, or Improved Modified Dry-Set Cement Mortar; 2023.
- C. ANSI A108.1c - Contractor's Option: Installation of Ceramic Tile in the Wet-Set Method with Portland Cement Mortar or Installation of Ceramic Tile on a Cured Portland Cement Mortar Setting Bed with Dry-Set, Modified Dry-Set, or Improved Modified Dry-Set Cement Mortar; 2023.
- D. ANSI A108.2 - American National Standard General Requirements: Materials, Environmental and Workmanship; 2019.
- E. ANSI A108.4 - American National Standard Specifications for Installation of Ceramic Tile with Organic Adhesive or Water Cleanable Tile-Setting Epoxy Adhesive; 2023.
- F. ANSI A108.5 - Setting of Ceramic Tile with Dry-Set Cement Mortar, Modified Dry-Set Cement Mortar, EGP (Exterior Glue Plywood) Modified Dry-Set Cement Mortar, or Improved Modified Dry-Set Cement Mortar; 2023.
- G. ANSI A108.6 - American National Standard Specifications for Installation of Ceramic Tile with Chemical Resistant, Water Cleanable Tile-Setting and -Grout Epoxy; 2023.
- H. ANSI A108.8 - American National Standard Specifications for Installation of Ceramic Tile with Chemical Resistant Furan Resin Mortar and Grout; 1999 (Reaffirmed 2024).
- I. ANSI A108.9 - American National Standard Specifications for Installation of Ceramic Tile with Modified Epoxy Emulsion Mortar/Grout; 2023.
- J. ANSI A108.10 - American National Standard Specifications for Installation of Grout in Tilework; 2017 (Reaffirmed 2022).
- K. ANSI A108.12 - Installation of Ceramic Tile with EGP (Exterior Glue Plywood) Modified Dry-Set Mortar; 2023.
- L. ANSI A108.13 - American National Standard for Installation of Load Bearing, Bonded, Waterproof Membranes for Thin-Set Ceramic Tile and Dimension Stone; 2005 (Reaffirmed 2021).
- M. ANSI A108.19 - American National Standard Specifications for Interior Installation of Gauged Porcelain Tiles and Gauged Porcelain Tile Panels/Slabs by the Thin-Bed Method Bonded with Modified Dry-Set Cement Mortar or Improved Modified Dry-Set Cement Mortar; 2020.

- N. ANSI A108.20 - American National Standard Specifications for Exterior Installation of Gauged Porcelain Tiles and Gauged Porcelain Tile Panels/Slabs; 2020.
- O. ANSI A118.3 - American National Standard Specifications for Chemical Resistant, Water Cleanable Tile-Setting and -Grouting Epoxy and Water Cleanable Tile-Setting Epoxy Adhesive; 2021.
- P. ANSI A118.4 - American National Standard Specifications for Modified Dry-Set Cement Mortar; 2023.
- Q. ANSI A118.12 - American National Standard Specifications for Crack Isolation Membranes for Thin-Set Ceramic Tile and Dimension Stone Installation; 2014 (Reaffirmed 2024).
- R. ANSI A137.1 - American National Standard Specifications for Ceramic Tile; 2022.
- S. TCNA (HB) - Handbook for Ceramic, Glass, and Stone Tile Installation; 2025.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Convene a preinstallation meeting one week before starting work of this section; require attendance by affected installers.

1.05 SUBMITTALS

- A. Product Data: Provide manufacturers' data sheets on tile, mortar, grout, and accessories. Include instructions for using grouts and adhesives.
- B. Shop Drawings: Indicate tile layout, perimeter conditions, junctions with dissimilar materials, control and expansion joints, ceramic accessories, and setting details.
- C. Samples: Mount tile and apply grout on two plywood panels, minimum 18 by 18 inches (457 by 457 mm) in size illustrating pattern, color variations, and grout joint size variations.
- D. Installer's Qualification Statement:
- E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements, for additional provisions.
 - 2. Extra Tile: 10 square feet (1 square meters) of each size, color, and surface finish combination.

1.06 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Company specializing in performing tile installation, with minimum of five years of documented experience.

PART 2 PRODUCTS

2.01 TILE

- A. Manufacturers: Provide per Finish Materials Legend on the drawings .
- B. Porcelain Wall and Floor Tile (CWT-1, CFT-1) : ANSI A137.1 standard grade.
 - 1. Product, Size, Color, Pattern: As indicated on the drawings.
 - 2. Thickness: 5/16 inch (8 mm).

2.02 TRIM AND ACCESSORIES

- A. Trim: Matching bullnose shapes in sizes coordinated with field tile.
 - 1. Applications:
 - a. Open Edges: Bullnose.
 - 2. Manufacturers: Same as for tile.
- B. Metal Trim: Anodized aluminum, style and dimensions to suit application, for setting using tile mortar or adhesive.
 - 1. Application: Floor to wall joints.
 - 2. Manufacturer/Product:

- a. Basis or Design: Schluter-Systems: www.schluter.com/#sle, DILEX-AHK

2.03 SETTING MATERIALS

- A. Provide setting, grout materials, and accessory materials from same manufacturer.
- B. Manufacturers:
 - 1. ARDEX Engineered Cements: www.ardexamericas.com/#sle.
 - 2. Custom Building Products: www.custombuildingproducts.com/#sle.
 - 3. LATICRETE International, Inc: www.laticrete.com/#sle.
 - 4. MAPEI Corporation: www.mapei.com/#sle.
 - 5. Substitutions: See Section 01 60 00 - Product Requirements.
- C. Polymer-Fortified Latex-Portland Cement Mortar Bond Coat: ANSI A118.4.

2.04 GROUTS

- A. Provide setting and grout materials from same manufacturer.
- B. Epoxy Grout: ANSI A118.3 chemical resistant and water-cleanable epoxy grout.
 - 1. Applications: Wall and Floor tile.
 - 2. Color(s): As selected by Architect from manufacturer's full line.

2.05 MAINTENANCE MATERIALS

2.06 ACCESSORY MATERIALS

- A. Waterproofing and Concrete Floor Slab Crack Isolation Membrane: Material complying with ANSI A118.10 and ANSI A118.12.
 - 1. Crack Resistance: No failure at 1/8 inch (3.2 mm) gap, minimum.
 - 2. Fluid or Trowel Applied Type:
 - a. Material: Synthetic rubber or Acrylic.
 - b. Thickness: 20 mils (0.5 mm), maximum.
 - c. Products:
 - 1) RedGard Waterproofing and Crack Prevention Membrane by Custom Building Products.
 - 2) Hydro Ban by Laticrete International, Inc.
 - 3) Mapelastic AquaDefense by Mapei Corporation.
 - 4) S 1-K by Ardex.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that wall surfaces are smooth and flat within the tolerances specified for that type of work, are dust-free, and are ready to receive tile.

3.02 PREPARATION

- A. Protect surrounding work from damage.
- B. Vacuum clean surfaces and damp clean.
- C. Seal substrate surface cracks with filler. Level existing substrate surfaces to acceptable flatness tolerances.

3.03 INSTALLATION - GENERAL

- A. Install tile and grout in accordance with applicable requirements of ANSI A108.1a through ANSI A108.20, manufacturer's instructions, and TCNA (HB) recommendations.
- B. Lay tile to pattern indicated. Do not interrupt tile pattern through openings.
- C. Cut and fit tile to penetrations through tile, leaving sealant joint space. Form corners and bases neatly. Align floor joints.

- D. Place tile joints uniform in width, subject to variance in tolerance allowed in tile size. Make grout joints without voids, cracks, excess mortar or excess grout, or too little grout.
- E. Form internal angles square and external angles bullnosed.
- F. Install non-ceramic trim in accordance with manufacturer's instructions.
- G. Sound tile after setting. Replace hollow sounding units.
- H. Keep control and expansion joints free of mortar, grout, and adhesive.
- I. Prior to grouting, allow installation to completely cure; minimum of 48 hours.
- J. Grout tile joints unless otherwise indicated.
- K. At changes in plane and tile-to-tile control joints, use tile sealant instead of grout, with either bond breaker tape or backer rod as appropriate to prevent three-sided bonding.

3.04 INSTALLATION - FLOORS - THIN-SET METHODS

- A. Over interior concrete substrates, install in accordance with TCNA (HB) Method F113, dry-set or latex-Portland cement bond coat, with epoxy grout.
- B. Over wood substrates, install in accordance with TCNA (HB) Method F142, with standard grout, unless otherwise indicated.
- C. Install tile-to-tile floor movement joints in accordance with TCNA (HB) Method EJ171F.

3.05 INSTALLATION - WALL TILE

- A. Over cementitious backer units on studs, install in accordance with TCNA (HB) Method W244, using membrane at toilet rooms.

3.06 CLEANING

- A. Clean tile and grout surfaces.

3.07 PROTECTION

- A. Do not permit traffic over finished floor surface for 4 days after installation.

END OF SECTION

**SECTION 09 51 00
ACOUSTICAL CEILINGS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Suspended metal grid ceiling system.
- B. Acoustical units.

1.02 REFERENCE STANDARDS

- A. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2025.
- B. ASTM C635/C635M - Standard Specification for Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings; 2022.
- C. ASTM C636/C636M - Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels; 2019.
- D. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2024.
- E. ASTM E1264 - Standard Classification for Acoustical Ceiling Products; 2023.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Sequence work to ensure acoustical ceilings are not installed until building is enclosed, sufficient heat is provided, dust generating activities have terminated, and overhead work is completed, tested, and approved.
- B. Do not install acoustical units until after interior wet work is dry.

1.04 SUBMITTALS

- A. Shop Drawings: Indicate grid layout and related dimensioning, method of attaching hangers to structure and items penetrating finished ceiling.
 - 1. Minimum Drawing Scale: 1/8 inch = 1 foot.
- B. Product Data: Provide data on suspension system components and acoustical units.
- C. Samples: Submit two samples 3"x3" min illustrating material and finish of acoustical units.
- D. Samples: Submit two samples each, 12" long, of suspension system main runner, cross runner, and perimeter molding.
- E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. Extra Acoustical Units and Suspension System Components: Quantity equal to 2 percent of total installed.

1.05 QUALITY ASSURANCE

- A. Suspension System Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- B. Acoustical Unit Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.06 FIELD CONDITIONS

- A. Maintain temperature and humidity ranges that meet product warranty requirements prior to, during, and after acoustical unit installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Source Limitations: Obtain each type of acoustical ceiling system from single manufacturer.

- B. Acoustic Panels (ACT-1, ACT-2): Provide per Finish Materials Legends on the drawings.
- C. Suspension Systems:
 - 1. Same as for acoustical units.

2.02 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Smoke-Developed Index: 450 or less.
 - 2. Flame-Spread Index: Class A according to ASTM E 1264.
- B. Seismic Performance: Ceiling systems designed to withstand the effects of earthquake motions determined according to ASCE 7 for Seismic Design Category DEF (northern California) and complying with the following:
 - 1. Local authorities having jurisdiction.
 - 2. ASTM E 580.
 - 3. Cisca 0-2.
- C. No materials containing formaldehyde are permitted to be installed as part of this work.

2.03 ACOUSTICAL UNITS

- A. Acoustical Units - General: ASTM E1264, Class A.
- B. Acoustical Panels: Mineral fiber, with the following characteristics:
 - 1. Classification: ASTM E1264 .
 - 2. Size: As indicated on the drawings.
 - 3. Color: White.
 - 4. Suspension System: Exposed grid.
 - 5. Products: Provide per Finish Legend on the Drawings

2.04 SUSPENSION SYSTEM(S)

- A. Metal Suspension Systems - General: Complying with ASTM C635/C635M; die cut and interlocking components, with perimeter moldings, hold down clips, stabilizer bars, clips, and splices as required.
 - 1. Materials:
 - a. Steel Grid: ASTM A653/A653M, G60 coating hot-dipped galvanized, unless otherwise indicated.
- B. Exposed Suspension System: Hot-dipped galvanized steel grid with aluminum cap.
 - 1. Application(s): Seismic.
 - 2. Structural Classification: Heavy-duty, when tested in accordance with ASTM C635/C635M.
 - 3. Finish: Baked enamel.
 - 4. Color: White.
 - 5. Basis-of-Design Product: Match existing.

2.05 ACCESSORIES

- A. Support Channels and Hangers: Galvanized steel; size and type to suit application, seismic requirements, and ceiling system flatness requirement specified.
- B. Hanger Wire: 12 gauge, 0.08 inch (2 mm) galvanized steel wire.
- C. Hold-Down Clips: Manufacturer's standard clips to suit application.
- D. Seismic Clips: Manufacturer's standard clips for seismic conditions and to suit application.
- E. Perimeter Moldings: Same metal and finish as grid.
 - 1. Angle Molding: L-shaped, for mounting at same elevation as face of grid.
 - 2. Acoustical Sealant For Perimeter Moldings: Non-hardening, non-skinning, for use in conjunction with suspended ceiling system.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that layout of hangers will not interfere with other work.

3.02 PREPARATION

- A. Install after major above-ceiling work is complete.
- B. Coordinate the location of hangers with other work.

3.03 INSTALLATION - SUSPENSION SYSTEM

- A. Install suspension system in accordance with CBC Section 808, ASTM C635, ASTM C636/C636M and manufacturer's instructions and as supplemented in this section.
- B. Rigidly secure system, including integral mechanical and electrical components, for maximum deflection of 1:360.
- C. Perimeter Molding: Install at intersection of ceiling and vertical surfaces and at junctions with other interruptions.
 - 1. Use longest practical lengths.
- D. Suspension System, Non-Seismic: Hang suspension system independent of walls, columns, ducts, pipes and conduit. Where carrying members are spliced, avoid visible displacement of face plane of adjacent members.
- E. Where ducts or other equipment prevent the regular spacing of hangers, reinforce the nearest affected hangers and related carrying channels to span the extra distance.
- F. Do not support components on main runners or cross runners if weight causes total dead load to exceed deflection capability.
- G. Support fixture loads using supplementary hangers located within 6 inches (152 mm) of each corner, or support components independently.
- H. Do not eccentrically load system or induce rotation of runners.

3.04 INSTALLATION - ACOUSTICAL UNITS

- A. Install acoustical units in accordance with manufacturer's instructions.
- B. Fit acoustical units in place, free from damaged edges or other defects detrimental to appearance and function.
- C. Lay directional patterned units as indicated on Drawings.
- D. Fit border trim neatly against abutting surfaces.
- E. Install acoustical units level, in uniform plane, and free from twist, warp, and dents.
- F. Cutting Acoustical Units:
 - 1. Make field cut edges of same profile as factory edges.
- G. Where round obstructions occur, provide preformed closures to match perimeter molding.
- H. Install hold-down clips on panels within 20 ft (6 m) of an exterior door.

3.05 TOLERANCES

- A. Maximum Variation from Flat and Level Surface: 1/8 inch in 10 feet (3 mm in 3 m).
- B. Maximum Variation from Plumb of Grid Members Caused by Eccentric Loads: 2 degrees.

3.06 CLEANING

- A. Clean surfaces.
- B. Replace damaged or abraded components.

END OF SECTION

**SECTION 09 65 00
RESILIENT FLOORING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Resilient tile flooring.
- B. Resilient base.
- C. Resilient stair accessories.
- D. Installation accessories.

1.02 RELATED REQUIREMENTS

- A. Section 09 05 61 - Common Work Results for Flooring Preparation: Concrete slab moisture and alkalinity testing and remediation procedures.

1.03 REFERENCE STANDARDS

- A. ASTM F1303 - Standard Specification for Sheet Vinyl Floor Covering with Backing; 2004 (Reapproved 2021).
- B. ASTM F1344 - Standard Specification for Rubber Floor Tile; 2021a.
- C. ASTM F1861 - Standard Specification for Resilient Wall Base; 2021 (Reapproved 2025).

1.04 SUBMITTALS

- A. Product Data: Provide data on specified products, describing physical and performance characteristics; including sizes, patterns and colors available; and installation instructions.
- B. Shop Drawings: Indicate seaming plans and floor patterns.
- C. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. Extra Flooring Material: Quantity equivalent to 300 square feet of each type and color.
 - 2. Extra Wall Base: Quantity equivalent to 5 percent of each type and color.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in installing specified flooring with minimum three years documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Store all materials off of the floor in an acclimatized, weather-tight space.

PART 2 PRODUCTS

2.01 TILE FLOORING

- A. Rubber Tile (RFT-1, RFT-2): Homogeneous, color and pattern throughout thickness.
 - 1. Basis of Design: As indicated on Finish Material Legends on the Drawings.
 - 2. Minimum Requirements: Comply with ASTM F1344, of Class corresponding to type specified.
 - 3. Size: 24 in x 24 in (61cm x 61cm).
 - 4. Total Thickness: 0.118 in (3mm).
 - 5. Texture: Smooth.

2.02 STAIR COVERING

- A. Stair Nosings: 1-1/2 inch (38 mm) minimum horizontal return, 1-1/2 inch (38 mm) minimum vertical return, full width of stair tread in one piece,
 - 1. Manufacturers:
 - a. Johnsonite, a Tarkett Company: www.johnsonite.com/#sle.
 - b. Mannington Commercial: www.manningtoncommercial.com/#sle.
 - 2. Material: Vinyl.

3. Profile and Color: To be selected by Architect from manufacturer's full range.

2.03 RESILIENT BASE

- A. Resilient Base (RB-1) Type TP, rubber, thermoplastic and Resilient Base (RB-2, RB-3, RB-4): ASTM F1861, Type TS, rubber, vulcanized thermoset.
 1. Manufacturers: Provide per Finish Materials Legend on the Drawings.
 2. Height and Color: As indicated on drawings.
 3. Style:
 - a. For Use with Resilient Floor Coverings: Cove (with top-set toe).
 - b. For Use with Carpet: Cove (toeless).

2.04 ACCESSORIES

- A. Primers and Adhesives: Waterproof; types recommended by flooring manufacturer.
- B. Moldings, Transition and Edge Strips: Vinyl.
 1. Manufacturers:
 - a. Mannington Commercial: www.manningtoncommercial.com#sle.
 - b. Johnsonite / Tarkett: https://commercial.tarkett.com/en_US/brand/johnsonite.
 - c. Substitutions: See Section 01 60 00 - Product Requirements.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that surfaces are flat to tolerances acceptable to flooring manufacturer, free of cracks that might telegraph through flooring, clean, dry, and free of curing compounds, surface hardeners, and other chemicals that might interfere with bonding of flooring to substrate.
- B. Verify that wall surfaces are smooth and flat within the tolerances specified for that type of work, are dust-free, and are ready to receive resilient base.

3.02 PREPARATION

- A. Prepare floor substrates as recommended by flooring and adhesive manufacturers.
- B. Remove subfloor ridges and bumps. Fill minor low spots, cracks, joints, holes, and other defects with subfloor filler to achieve smooth, flat, hard surface.
- C. Prohibit traffic until filler is fully cured.
- D. Clean substrate.

3.03 INSTALLATION - GENERAL

- A. Starting installation constitutes acceptance of subfloor conditions.
- B. Install in accordance with manufacturer's written instructions.

3.04 INSTALLATION - TILE FLOORING

- A. Mix tile from container to ensure shade variations are consistent when tile is placed, unless otherwise indicated in manufacturer's installation instructions.

3.05 INSTALLATION - RESILIENT BASE

- A. Fit joints tightly and make vertical. Maintain minimum dimension of 18 inches (45 mm) between joints.
- B. Install base on solid backing. Bond tightly to wall and floor surfaces.

3.06 INSTALLATION - STAIR COVERINGS

- A. Adhere over entire surface. Fit accurately and securely.

3.07 CLEANING

- A. Remove excess adhesive from floor, base, and wall surfaces without damage.
- B. Clean in accordance with manufacturer's written instructions.

3.08 PROTECTION

- A. Prohibit traffic on resilient flooring for 48 hours after installation.

END OF SECTION

**SECTION 09 68 13
TILE CARPETING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Carpet tile, fully adhered.

1.02 RELATED REQUIREMENTS

- A. Section 09 05 61 - Common Work Results for Flooring Preparation: Concrete slab moisture and alkalinity testing and remediation procedures.

1.03 SUBMITTALS

- A. Product Data: Provide data on specified products, describing physical and performance characteristics; sizes, patterns, colors available, and method of installation.
- B. Samples: Submit two carpet tiles illustrating color and pattern design for each carpet color selected.
- C. Installer's Qualification Statement.
- D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements, for additional provisions.
 - 2. Extra Carpet Tiles: Quantity equal to 5 percent of total installed of each color and pattern installed.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing specified carpet tile with minimum three years documented experience.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Tile Carpeting: As indicated on the Finish Materials Legends on the Drawings.

2.02 MATERIALS

- A. Tile Carpeting (CPT-1, CPT-2, CPT-3, CPT-4): Tufted, manufactured in one color dye lot.
 - 1. Construction: Multi-Level Pattern Loop.
 - 2. Material: Nylon.
 - 3. Dye Method: Solution Dyed / Yarn Dyed
 - 4. Tufted Weight: 18 oz/sq yd | 610.3 g/sq m minimum

2.03 ACCESSORIES

- A. Subfloor Filler: White premix latex; type recommended by flooring material manufacturer.
- B. Edge Strips: Vinyl, color as selected by Architect.
- C. Stair Nosing: As specified in Section 09 65 00.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Starting installation constitutes acceptance of subfloor conditions.
- B. Install carpet tile in accordance with manufacturer's instructions.
- C. Blend carpet from different cartons to ensure minimal variation in color match.
- D. Cut carpet tile clean. Fit carpet tight to intersection with vertical surfaces without gaps.
- E. Lay carpet tile in square pattern, with pile direction parallel to next unit, set parallel to building lines.
- F. Trim carpet tile neatly at walls and around interruptions.

- G. Complete installation of edge strips, concealing exposed edges.

3.02 INSTALLATION ON STAIRS

- A. Use one piece of carpet for each tread and the riser below. Apply seam adhesive to all cut edges.
- B. Lay carpet with pile direction in the length of the stair.
- C. Adhere carpet tight to stair treads and risers.

3.03 CLEANING

- A. Remove excess adhesive without damage, from floor, base, and wall surfaces.
- B. Clean and vacuum carpet surfaces.

END OF SECTION

**SECTION 09 72 00
WALL COVERINGS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Wall covering.

1.02 REFERENCE STANDARDS

- A. ASTM D1308 - Standard Test Method for Effect of Household Chemicals on Clear and Pigmented Coating Systems; 2020.
- B. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2024.
- C. ASTM F793/F793M - Standard Classification of Wall Coverings and Ceiling Coverings by Use Characteristics; 2025.

1.03 SUBMITTALS

- A. Product Data: Provide data on wall covering and adhesive.
- B. Shop Drawings: Indicate wall elevations with seaming layout as applicable
- C. Samples: Submit two samples of wall covering, 12 inches x12 inches in size illustrating color, finish, and texture.
- D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. Extra Wall Covering Materials: 25 linear feet (8 linear m) of each color and pattern of wall covering; store where directed.

1.04 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Inspect roll materials at arrival on site, to verify acceptability.
- B. Protect packaged adhesive from temperature cycling and cold temperatures.
- C. Do not store roll goods on end.

1.06 FIELD CONDITIONS

- A. Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the adhesive or wall covering product manufacturer.
- B. Maintain these conditions 24 hours before, during, and after installation of adhesive and wall covering.

PART 2 PRODUCTS

2.01 WALL COVERINGS

- A. General Requirements:
 - 1. Surface Burning Characteristics: Flame spread/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84.
 - 2. Chemical and Stain Resistance: No visible staining or discoloration and no damage to surface texture when tested in accordance with ASTM D1308.
- B. Wall Covering WP-3): Fabric-backed vinyl roll stock,
 - 1. 100% Non-Phthalate Vinyl, High Traffic.
 - 2. Comply with ASTM F793/F793M, Category V, Type II.
 - 3. Total Weight: 25 oz/sq yd (800 g/sq m).
 - 4. Roll Width: 52 inches (1320 mm).

- C. Mounting: Type recommended by wall covering manufacturer to suit application to substrate.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that substrate surfaces are prime painted and ready to receive work, and comply with requirements of wall covering manufacturer.

3.02 PREPARATION

- A. Wash impervious surfaces with tetra-sodium phosphate, rinse and neutralize; wipe dry.
B. Surface Appurtenances: Remove or mask electrical plates, hardware, light fixture trim, escutcheons, and fittings prior to preparing surfaces or finishing.

3.03 INSTALLATION

- A. Apply mounting system or adhesive and wall covering in accordance with manufacturer's instructions.
B. Apply adhesive to wall surface immediately prior to application of wall covering.
C. Apply wall covering smooth, without wrinkles, gaps or overlaps. Eliminate air pockets and ensure full bond to substrate surface.
D. Butt edges tightly.
E. Remove excess adhesive while wet from seam before proceeding to next wall covering sheet. Wipe clean with dry cloth.

3.04 CLEANING

- A. Clean wall coverings of excess adhesive, dust, dirt, and other contaminants.
B. Reinstall wall plates and accessories removed prior to work of this section.

3.05 PROTECTION

- A. Do not permit construction activities at or near finished wall covering areas.

END OF SECTION

**SECTION 09 83 22
ACOUSTIC DRAPERY**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Acoustical drapery fabrics.
- B. Sound-absorbing assemblies: drapery and panels.
- C. Drapery tracks.

1.02 REFERENCE STANDARDS

- A. ASTM C423 - Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method; 2023, with Editorial Revision (2024).
- B. FM (AG) - FM Approval Guide; Current Edition.
- C. ITS (DIR) - Directory of Listed Products; Current Edition.
- D. NFPA 701 - Standard Methods of Fire Tests for Flame Propagation of Textiles and Films; 2023, with Errata.
- E. UL (DIR) - Online Certifications Directory; Current Edition.

1.03 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data:
 - 1. Provide data for drapery material, treatments, and fire rating.
- C. Shop Drawings:
 - 1. Indicate drapery locations.
- D. Samples: Submit one 24 inch by 24 inch (600 mm by 600 mm) panel of each heading, side hem, and bottom hem indicated.
- E. Installer's qualification statement.

1.04 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing work of type specified and with at least three years of documented experience and approved by manufacturer.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver after other finish work, including painting, is complete, and spaces are otherwise ready for occupancy.

PART 2 PRODUCTS

2.01 FABRICATORS

- A. Acoustic Drapery (AD-1) & Acoustic Privacy Panel (AP-1):
 - 1. Refer to Finish Materials Legend on the Drawings.

2.02 PERFORMANCE REQUIREMENTS

- A. Fire-Test Characteristics: Acoustic drapery fabrics in compliance with NFPA 701 flame propagation fire test requirements conducted by authorized testing agency, listed by UL (DIR), ITS (DIR), or FM (AG) and acceptable to authorities having jurisdiction.
 - 1. Permanently attach label to fabric of each curtain assembly indicating fabric treatment as follows:
 - a. Inherently Flame Retardant (IFR), fibers/yarns that are non-combustible for life of fabric.
 - 2. Permanently attach swatch of matching fabric from same dye lot, at least 12 inches (305 mm) square, to backside of curtain assembly for use as fire-resistance test strip.

2.03 SOUND ABSORBING ASSEMBLIES

- A. Acoustic Drapery: Window treatment.
 - 1. Noise Reduction Coefficient (NRC) Rating: 0.65, when tested in accordance with ASTM C423.
 - 2. Drapery Fabric:
 - a. Front Face Layer:
 - 1) Fabric & Color: As indicated on drawings.
- B. Acoustic Privacy Panel:
 - 1. Suspended Sola felt panel room divider.
 - 2. Color and pattern: As indicated on drawings.

2.04 ACOUSTICAL DRAPERY FABRICS

- A. Provide drapery of matching fabric and color from single dye lot. When size and quantity of drapery exceeds maximum dye lot size, provide curtain or adjacent pair of drapery from only one dye lot, and arrange curtain dye lots to minimize differences.

2.05 DRAPERY TRACKS

- A. Carriers and Other Components: As recommended by fabricator.
- B. Components:
 - 1. Tracks: Extruded aluminum, 0.050 inch (0.508 mm), alloy 6063T5 side stacking operating traverse rods, heavy duty channel track.
 - a. Track Color: As selected by Architect..
 - 2. Carriers: Nylon roller 3 per foot (10 per m).
 - 3. Draw: Baton draw
 - a. Control Wand: Extruded hollow plastic; square shape; nonremovable type; length of window opening height less 3 inches (76.2 mm).

2.06 FABRICATION - DRAPERY

- A. General: Provide vertical seams unless otherwise indicated, locate vertical seams so they do not fall on faces of pleats, and only use fabric that is cut greater than half width of fabric. For fabric widths less than width of specified fullness panel: Use equal widths not less than one-half width of fabric located at ends of panel.
- B. Place full width of material at center meeting edges.
- C. Provide drapery that is tabled square and hems without pucker.
- D. Fabricate headings to stand erect.
- E. Provide Additional Panel Width:
- F. Seams:
 - 1. Match patterns.
 - 2. Lay seams straight and flat.
 - 3. Lay vertical seams only.
- G. Top Hems:
 - 1. Fabricate by double-stitching 3-1/2 inches (88.9 mm) wide, heavy jute or laminated synthetic webbing to top edge at backside of curtain with at least 2 inches (50.8 mm) of face fabric turned under.
- H. Side Hems:
 - 1. Double-turn fabric.
 - 2. Blindstitch: Stitching not visible on face of drape.
 - 3. Turnbacks: Fabricate leading-edge and trailing-edge turnbacks for traveler drapery by folding back at least 12 inches (304.8 mm) of face fabric, with at least 1 inch (25.4 mm) tuck, and vertically secured by sewing.

- I. Bottom Hems:
 - 1. Hem Width: 4 inches (101.6 mm).
 - 2. Double-turn fabric.
- J. Inner Layer:
 - 1. Extend from top of drape to within 1/2 inch (12.7 mm) of lining bottom hem.
 - 2. Extend to leading edge of side hems.
- K. Back Lining Layer:
 - 1. Provide linings equal to width of drapery fabric.
 - 2. Join linings to drapery fabric at top by blind stitching.
 - 3. Side Hems: Turn face fabric back 1-1/2 inches (38.1 mm) and blind stitch.

2.07 ACCESSORIES

- A. Hooks or snaps: As recommended by drapery track manufacturer.
- B. Tiebacks: Fabricate from same fabric as curtain facing.
 - 1. 2 inches (50.8 mm) wide by 24 inches (609.6 mm) long.
- C. Hardware for acoustic panel: As recommended by manufacturer.
 - 1. Stainless steel.

PART 3 EXECUTION

3.01 DRAPERY INSTALLATION

- A. Install drapery hooks.
- B. Install drapery tracks to substrate as indicated, level and straight for smooth operation.
- C. Install drapery tracks in accordance with manufacturer's instructions.
- D. Extend track 12 inches (300 mm) both sides with window trim for single track; 18 inches (450 mm) for double track where exposed.
- E. Attach drapes to tracks using hooks, snaps, or other methods recommended by curtain fabricator.
- F. Install tiebacks.

3.02 PANEL INSTALLATION

- A. As directed by Architect and in accordance with manufacturer's instructions.

3.03 ADJUSTING

- A. Adjust drapery hardware for smooth operation.

3.04 CLEANING

- A. Remove and replace drapes that are stained or soiled.

END OF SECTION

**SECTION 09 84 30
SOUND-ABSORBING WALL AND CEILING UNITS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Sound-absorbing wall panels.
- B. Sound-absorbing ceiling baffles.
- C. Mounting accessories.

1.02 REFERENCE STANDARDS

- A. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2024.

1.03 SUBMITTALS

- A. Product Data: Manufacturer's printed data sheets for products specified.
- B. Shop Drawings: Fabrication and installation details, panel layout.
- C. Verification Samples: Fabricated samples of each type of panel specified; 4 inches by 4 inches.
- D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. Extra Panels: Quantity equal to 5 percent of total installed, but not less than one of each type.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Protect acoustical units from moisture during shipment, storage, and handling. Deliver in factory-wrapped bundles; do not open bundles until units are needed for installation.
- B. Store units flat, in dry, well-ventilated space; do not stand on end.
- C. Protect edges from damage.

PART 2 PRODUCTS

2.01 SOUND-ABSORBING UNITS

- A. Manufacturers/Products:
 - 1. Ceiling Baffles and Felt Wall Panel:
 - 2. Fabric Wall Panel:
 - a. Basis of Design: Audimute Fabric Acoustic Panel FR70.
- B. General:
 - 1. Prefinished, factory assembled acoustic panels.
 - 2. Surface Burning Characteristics: Flame spread index of 25 or less and smoke developed index of 450 or less, when tested in accordance with ASTM E84.
- C. Fabric-Covered Acoustical Panels for Walls (WP-5):
 - 1. Panel Core: Manufacturer's standard PET (Polyethylene Terephthalate) and recycled cotton core.
 - a. Facing: Polyester fabric per Finish Materials Legend.
 - 2. Panel Size and Layout: As indicated by Architect.
 - 3. Panel Thickness: 1 1/2 inches (38.1 mm).
- D. Linear Acoustic Ceiling Baffles and Wall Panels (CLG-2, CLG-3, CLG-4, CLG-5, FP-1, FP-2):
 - 1. Material: 100 percent polyester felt
 - 2. BSize: As indicated on drawings.
 - 3. Thickness: 1 inch (24 mm).
 - 4. Color: As indicated.

2.02 FABRICATION

- A. General: Fabricate panels to sizes and configurations as indicated.

2.03 ACCESSORIES

- A. Ceiling-Suspended Accessories: Manufacturer's standard accessories at locations as indicated on each acoustical unit, sized appropriately for weight of acoustical unit.
- B. Panel Adhesive: Acceptable to acoustical panel manufacturer for application as indicated.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install acoustical units in locations as indicated, following manufacturer's installation instructions.
- B. Install mounting accessories and supports in accordance with shop drawings.
- C. Suspend ceiling baffles at locations and heights as indicated.
- D. Install acoustical units to construction tolerances of plus or minus 1/16 inch (1.6 mm) for the following:
 - 1. Plumb and level.
 - 2. Flatness.

3.02 CLEANING

- A. Clean sound-absorptive panels upon completion of installation from dust and other foreign materials, following manufacturer's instructions.

3.03 PROTECTION

- A. Provide protection of installed acoustical panels until Date of Substantial Completion.
- B. Replace panels that cannot be cleaned and repaired to satisfaction of the Architect.

END OF SECTION

**SECTION 09 91 13
EXTERIOR PAINTING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Surface preparation.
- B. Field application of paints.
- C. Scope: Finish exterior surfaces exposed to view, unless fully factory-finished.
- D. Do Not Paint or Finish the Following Items:
 - 1. Items factory-finished unless otherwise indicated; materials and products having factory-applied primers are not considered factory finished.
 - 2. Items indicated to receive other finishes.
 - 3. Items indicated to remain unfinished.
 - 4. Fire rating labels, equipment serial number and capacity labels, and operating parts of equipment.
 - 5. Floors, unless specifically indicated.
 - 6. Glass.
 - 7. Concealed pipes, ducts, and conduits.

1.02 RELATED REQUIREMENTS

- A. Section 09 91 23 - Interior Painting.

1.03 REFERENCE STANDARDS

- A. SSPC-SP 1 - Solvent Cleaning; 2015, with Editorial Revision (2016).
- B. SSPC-SP 2 - Hand Tool Cleaning; 2024.
- C. SSPC-SP 13 - Surface Preparation of Concrete; 2018.

1.04 SUBMITTALS

- A. Product Data: Provide complete list of products to be used, with the following information for each:
 - 1. Manufacturer's name, product name and/or catalog number, and general product category (e.g. "alkyd enamel").
 - 2. Cross-reference to specified paint system(s) product is to be used in; include description of each system.
- B. Samples: Submit three paper "draw down" samples, 8-1/2 by 11 inches (216 by 279 mm) in size, illustrating range of colors available for each finishing product specified.
 - 1. Where sheen is specified, submit samples in only that sheen.

1.05 QUALITY ASSURANCE

- A. Applicator Qualifications: Company specializing in performing the type of work specified with minimum 3 years experience.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site in sealed and labeled containers; inspect to verify acceptability.
- B. Container Label: Include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.
- C. Paint Materials: Store at minimum ambient temperature of 45 degrees F (7 degrees C) and a maximum of 90 degrees F (32 degrees C), in ventilated area, and as required by manufacturer's instructions.

1.07 FIELD CONDITIONS

- A. Do not apply materials when surface and ambient temperatures are outside the paint product manufacturer's temperature ranges.
- B. Follow manufacturer's recommended procedures for producing best results, including testing of substrates, moisture in substrates, and humidity and temperature limitations.
- C. Provide lighting level of 80 ft candles (860 lx) measured mid-height at substrate surface.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Provide paints and finishes from the same manufacturer to the greatest extent possible.
- B. Paints:
 - 1. Sherwin-Williams Company: www.sherwin-williams.com/#sle.
- C. Primer Sealers: Same manufacturer as top coats.

2.02 PAINTS AND FINISHES - GENERAL

- A. Paints and Finishes: Ready-mixed, unless required to be a field-catalyzed paint.
 - 1. Provide paints and finishes of a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating, with good flow and brushing properties, and capable of drying or curing free of streaks or sags.
 - 2. Supply each paint material in quantity required to complete entire project's work from a single production run.
 - 3. Do not reduce, thin, or dilute paint or finishes or add materials unless such procedure is described explicitly in manufacturer's product instructions.
- B. Colors: To be selected from manufacturer's full range of available colors.
 - 1. Selection to be made by Architect after award of contract.

2.03 PAINT SYSTEMS - EXTERIOR

- A. Exterior Surfaces to be Painted, Unless Otherwise Indicated: Including primed wood and primed metal.
 - 1. Two top coats and one coat primer.
 - 2. Top Coat(s): Exterior Waterborne Urethane Alkyd.
 - a. Product:
 - 1) Sherwin Williams Pro Industrial Waterbased Alkyd Urethane B53 Series (Gloss or Semi-Gloss).

2.04 PRIMERS

- A. Primers: Provide the following unless other primer is required or recommended by manufacturer of top coats.
 - 1. Latex Primer for Exterior Wood.
 - a. Product:
 - 1) Sherwin-Williams PrepRite ProBlock Primer B51.
 - 2. Primer for metal:
 - a. Product:
 - 1) Sherwin-Williams ProCryl B66-310.

PART 3 EXECUTION

3.01 PREPARATION

- A. Clean surfaces thoroughly and correct defects prior to application.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
- C. Remove or mask surface appurtenances, including electrical plates, hardware, light fixture trim, escutcheons, and fittings, prior to preparing surfaces for finishing.

- D. Seal surfaces that might cause bleed through or staining of topcoat.
- E. Remove mildew from impervious surfaces by scrubbing with solution of tetra-sodium phosphate and bleach. Rinse with clean water and allow surface to dry.
- F. Galvanized Surfaces:
 - 1. Remove surface contamination and oils and wash with solvent according to SSPC-SP 1.
 - 2. Prepare surface according to SSPC-SP 2.
- G. Exterior Wood Surfaces to Receive Opaque Finish: Remove dust, grit, and foreign matter. Seal knots, pitch streaks, and sappy sections. Fill nail holes with tinted exterior caulking compound after prime coat has been applied. Back prime concealed surfaces before installation.
- H. Metal Doors to be Painted: Prime metal door top and bottom edge surfaces.

3.02 APPLICATION

- A. Exterior Wood to Receive Opaque Finish: If final painting must be delayed more than 2 weeks after installation of woodwork, apply primer within 2 weeks and final coating within 4 weeks.
- B. Apply products in accordance with manufacturer's written instructions.
- C. Do not apply finishes to surfaces that are not dry. Allow applied coats to dry before next coat is applied.
- D. Apply each coat to uniform appearance.
- E. Vacuum clean surfaces of loose particles. Use tack cloth to remove dust and particles just prior to applying next coat.
- F. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.

3.03 CLEANING

- A. Collect waste material that could constitute a fire hazard, place in closed metal containers, and remove daily from site.

3.04 PROTECTION

- A. Protect finishes until completion of project.
- B. Touch-up damaged finishes after Substantial Completion.

END OF SECTION

**SECTION 09 91 23
INTERIOR PAINTING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Surface preparation.
- B. Field application of paints.
- C. Scope: Finish interior surfaces exposed to view, unless fully factory-finished and unless otherwise indicated.
- D. Do Not Paint or Finish the Following Items:
 - 1. Items factory-finished unless otherwise indicated; materials and products having factory-applied primers are not considered factory finished.
 - 2. Items indicated to receive other finishes.
 - 3. Items indicated to remain unfinished.
 - 4. Fire rating labels, equipment serial number and capacity labels, bar code labels, and operating parts of equipment.
 - 5. Floors, unless specifically indicated.
 - 6. Glass.
 - 7. Concealed pipes, ducts, and conduits.

1.02 RELATED REQUIREMENTS

- A. Section 09 91 13 - Exterior Painting.

1.03 REFERENCE STANDARDS

- A. 40 CFR 59, Subpart D - National Volatile Organic Compound Emission Standards for Architectural Coatings; U.S. Environmental Protection Agency; Current Edition.
- B. ASTM D4442 - Standard Test Methods for Direct Moisture Content Measurement of Wood and Wood-Based Materials; 2020 (Reapproved 2025).
- C. SSPC-SP 1 - Solvent Cleaning; 2015, with Editorial Revision (2016).

1.04 SUBMITTALS

- A. Product Data: Provide complete list of products to be used, with the following information for each:
 - 1. Manufacturer's name, product name and/or catalog number, and general product category (e.g., "alkyd enamel").
 - 2. Cross-reference to specified paint system products to be used in project; include description of each system.
- B. Samples: Submit three paper "draw down" samples, 8-1/2 by 11 inches (216 by 279 mm) in size, illustrating range of colors available for each finishing product specified.
 - 1. Where sheen is specified, submit samples in only that sheen.
- C. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements, for additional provisions.
 - 2. Extra Paint and Finish Materials: 5 gal (20 L) of each color; from the same product run, store where directed.
 - 3. Label each container with color in addition to the manufacturer's label.

1.05 QUALITY ASSURANCE

- A. Applicator Qualifications: Company specializing in performing the type of work specified with minimum three years experience and approved by manufacturer.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site in sealed and labeled containers; inspect to verify acceptability.

- B. Container Label: Include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.
- C. Paint Materials: Store at minimum ambient temperature of 45 degrees F (7 degrees C) and a maximum of 90 degrees F (32 degrees C), in ventilated area, and as required by manufacturer's instructions.

1.07 FIELD CONDITIONS

- A. Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the paint product manufacturer.
- B. Follow manufacturer's recommended procedures for producing best results, including testing of substrates, moisture in substrates, and humidity and temperature limitations.
- C. Provide lighting level of 80 fc (860 lux) measured mid-height at substrate surface.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Basis-of-Design Manufacturer: In compliance with requirements, provide Sherwin-Williams.
- B. Provide paints and finishes used in any individual system from the same manufacturer; no exceptions.

2.02 PAINTS AND FINISHES - GENERAL

- A. Paints and Finishes: Ready-mixed, unless intended to be a field-catalyzed paint.
 - 1. Provide paints and finishes of a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating, with good flow and brushing properties, and capable of drying or curing free of streaks or sags.
 - 2. Supply each paint material in quantity required to complete entire project's work from a single production run.
 - 3. Do not reduce, thin, or dilute paint or finishes or add materials unless such procedure is specifically described in manufacturer's product instructions.
- B. Volatile Organic Compound (VOC) Content:
 - 1. Provide paints and finishes that comply with the most stringent requirements specified in the following:
 - a. 40 CFR 59, Subpart D--National Volatile Organic Compound Emission Standards for Architectural Coatings.
 - b. Architectural coatings VOC limits of the State in which the Project is located.
 - 2. Determination of VOC Content: Testing and calculation in accordance with 40 CFR 59, Subpart D (EPA Method 24), exclusive of colorants added to a tint base and water added at project site; or other method acceptable to authorities having jurisdiction.
- C. Flammability: Comply with applicable code for surface burning characteristics.
- D. Sheens: Provide the sheens specified; where sheen is not specified, sheen will be selected later by Architect from the manufacturer's full line.
- E. Colors: As indicated on drawings.

2.03 PAINT SYSTEMS - INTERIOR

- A. Interior Surfaces to be Painted, Unless Otherwise Indicated: Including gypsum board and wood.
 - 1. Two top coats and one coat primer.
 - 2. Top Coat(s): Institutional Low Odor/VOC Interior Latex.
 - a. Products:
 - 1) Sherwin-Williams ProMar 200 Zero VOC Interior Latex.
 - (a) Sheen as selected by Architect.

- B. Interior Surfaces to be Painted: Shop primed steel.
 - 1. Top Coat(s): Urethane.
 - a. Products:
 - 1) Sherwin-Williams Pro Industrial B53 1150, Semi-Gloss.

2.04 PRIMERS

- A. Primers: Provide the following unless other primer is required or recommended by manufacturer of top coats.
 - 1. Interior Institutional Low Odor/VOC Primer Sealer.
 - a. Product:
 - 1) SW ProMar 200 Zero VOC Primer.
 - 2. Primer for steel or shop primed steel touch up:
 - a. Product:
 - 1) Sherwin-Williams ProCryl B66-310.

2.05 ACCESSORY MATERIALS

- A. Accessory Materials: Provide primers, sealers, cleaning agents, cleaning cloths, sanding materials, and clean-up materials as required for final completion of painted surfaces.
- B. Patching Material: Latex filler.
- C. Fastener Head Cover Material: Latex filler.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Do not begin application of paints and finishes until substrates have been adequately prepared.
- B. Verify that surfaces are ready to receive work as instructed by the product manufacturer.
- C. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially affect proper application.
- D. Test shop-applied primer for compatibility with subsequent cover materials.
- E. Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes unless moisture content of surfaces is below the following maximums:
 - 1. Gypsum Wallboard: 12 percent.
 - 2. Interior Wood: 15 percent, measured in accordance with ASTM D4442.

3.02 PREPARATION

- A. Clean surfaces thoroughly and correct defects prior to application.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
- C. Remove or mask surface appurtenances, including electrical plates, hardware, light fixture trim, escutcheons, and fittings, prior to preparing surfaces or finishing.
- D. Seal surfaces that might cause bleed through or staining of topcoat.
- E. Gypsum Board: Fill minor defects with filler compound. Spot prime defects after repair.
- F. Ferrous Metal:
 - 1. Solvent clean according to SSPC-SP 1.
 - 2. Shop-Primed Surfaces: Sand and scrape to remove loose primer and rust. Feather edges to make touch-up patches inconspicuous. Clean surfaces with solvent. Prime bare steel surfaces. Touch-up shop-primed item as required.
 - 3. Remove rust, loose mill scale, and other foreign substances using methods recommended in writing by paint manufacturer . Protect from corrosion until coated.

- G. Wood Surfaces to Receive Opaque Finish: Wipe off dust and grit prior to priming. Seal knots, pitch streaks, and sappy sections with sealer. Fill nail holes and cracks after primer has dried; sand between coats. Back prime concealed surfaces before installation.

3.03 APPLICATION

- A. Apply products in accordance with manufacturer's written instructions.
- B. Where adjacent sealant is to be painted, do not apply finish coats until sealant is applied.
- C. Do not apply finishes to surfaces that are not dry. Allow applied coats to dry before next coat is applied.
- D. Apply each coat to uniform appearance in thicknesses specified by manufacturer.
- E. Sand wood and metal surfaces lightly between coats to achieve required finish.
- F. Vacuum clean surfaces of loose particles. Use tack cloth to remove dust and particles just prior to applying next coat.
- G. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.

3.04 FIELD QUALITY CONTROL

- A. See Section 01 45 00 Quality Control, for general requirements for field inspection.

3.05 CLEANING

- A. Collect waste material that could constitute a fire hazard, place in closed metal containers, and remove daily from site.

3.06 PROTECTION

- A. Protect finishes until completion of project.

END OF SECTION

**SECTION 09 93 00
STAINING AND TRANSPARENT FINISHING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Field application of stains.
- B. Field application of transparent finishes.

1.02 REFERENCE STANDARDS

- A. MPI (APSM) - Master Painters Institute Architectural Painting Specification Manual; Current Edition.

1.03 SUBMITTALS

- A. Product Data: Provide complete list of products to be used, with the following information for each:
 - 1. Manufacturer's name, product name and catalog number, and general product category.
- B. Samples: Two samples on actual wood substrate to be finished, 4 inches by 4 inches in size, indicating selected colors and sheens for each system, with specified coats cascaded.

1.04 QUALITY ASSURANCE

- A. Applicator Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Transparent Finishes:
 - 1. PPG Paints: www.ppgpaints.com/#sle.
 - 2. Sherwin-Williams Company: www.sherwin-williams.com/#sle.

2.02 STAINS AND TRANSPARENT FINISHES - GENERAL

- A. Finishes:
 - 1. Provide finishes capable of being readily and uniformly dispersed to a homogeneous coating, with good flow and brushing properties, and capable of drying or curing free of streaks or sags.
 - 2. Provide materials compatible with one another and the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.
 - 3. Supply each finish material in quantity required to complete entire project's work from a single production run.
 - 4. Do not reduce, thin, or dilute finishes or add materials unless such procedure is specifically described in manufacturer's product instructions.

2.03 INTERIOR STAIN AND TRANSPARENT FINISH SYSTEMS

- A. Finish on Wood - Doors and Wall Paneling:
 - 1. Stain: Semi-transparent stain for wood, water based; MPI #186.
 - a. Products:
 - 1) Behr Fast Drying Water-Based Wood Stain [B4500].
 - 2) Substitutions: Section 01 60 00 - Product Requirements.
 - 2. Sealer: Water based, sanding sealer, clear.
 - a. Products:
 - 1) Pittsburgh Paints Deft Interior Water-Based Sanding Sealer, DFT61.
 - 2) Substitutions: Section 01 60 00 - Product Requirements.
 - 3. Top Coat: Clear water-based varnish.

- a. Products:
 - 1) Pittsburgh Paints Deft Interior Polyurethane Water-Based Acrylic, DFT159.
- 4. Top Coat Sheen: As selected by Architect.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that surfaces are ready to receive work as instructed by the product manufacturer.
- B. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially effect proper application.

3.02 PREPARATION

- A. Clean surfaces thoroughly and correct defects prior to application.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
- C. Remove or mask surface appurtenances, including electrical plates, hardware, light fixture trim, escutcheons, and fittings, prior to preparing surfaces or finishing.

3.03 APPLICATION

- A. Apply products in accordance with manufacturer's written instructions.
- B. Do not apply finishes to surfaces that are not dry. Allow applied coats to dry before next coat is applied.
- C. Apply each coat to uniform appearance in thicknesses specified by manufacturer.
- D. Sand wood surfaces lightly between coats to achieve required finish.
- E. Vacuum clean surfaces of loose particles. Use tack cloth to remove dust and particles just prior to applying next coat.
- F. Wood to Receive Transparent Finishes: Tint fillers to match wood. Work fillers into the grain before set. Wipe excess from surface.

3.04 CLEANING

- A. Collect waste material that could constitute a fire hazard, place in closed metal containers, and remove daily from site.

3.05 PROTECTION

- A. Protect finishes until completion of project.

END OF SECTION

**SECTION 10 14 23
PANEL SIGNAGE**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Panel signage.

1.02 REFERENCE STANDARDS

- A. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.
- B. ICC A117.1 - Accessible and Usable Buildings and Facilities; 2017.

1.03 SUBMITTALS

- A. Product Data: Manufacturer's product literature for each type of panel sign, indicating styles, font, foreground and background colors, locations, and overall dimensions of each sign.
- B. Shop Drawings:
 - 1. Include dimensions, locations, elevations, materials, text and graphic layout, attachment details, and schedules.
- C. Samples: Submit two samples of each type of sign, of size similar to that required for project, indicating sign style, font, and method of attachment.
- D. Manufacturer's qualification statement.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years of documented experience.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Package signs as required to prevent damage before installation.
- B. Store tape adhesive at normal room temperature.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Panel Signage:
 - 1. Best Sign Systems, Inc: www.bestsigns.com/#sle.
 - 2. Mohawk Sign Systems, Inc: www.mohawksign.com/#sle.
 - 3. Vista System LLC: www.vistasystem.com/#sle.
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 REGULATORY REQUIREMENTS

- A. Accessibility Requirements: Comply with ADA Standards and ICC A117.1 and applicable building codes, unless otherwise indicated; in the event of conflicting requirements, comply with the most restrictive requirements.

2.03 PANEL SIGNAGE

- A. Panel Signage, As indicated on drawings
 - 1. Application: Room and door signs.
 - 2. Description: Flat signs with engraved panel media, tactile characters.
 - 3. Total Thickness: 1/8 inch (3 mm).
 - 4. Color and Font, unless otherwise indicated in UCDH Master Signage Standards:
 - a. Character Font: Helvetica, Arial, or other sans serif font.
 - b. Character Case: Upper and lower case (title case).
 - c. Background Color: As scheduled.
 - d. Character Color: Contrasting color.

5. Material: Laminated colored plastic engraved through face to expose core as background color.
6. Tactile Letters: Raised 1/32 inch minimum.

2.04 ACCESSORIES

- A. Tape Adhesive: Double-sided tape, permanent adhesive.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that substrate surfaces are ready to receive work.
- B. Notify Architect if conditions are not suitable for installation of signs; do not proceed until conditions are satisfactory.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install with horizontal edges level.
- C. Locate panel signs and mount at heights indicated on drawings and in accordance with ADA Standards and ICC A117.1.
- D. Protect from damage until Substantial Completion; repair or replace damaged items.

END OF SECTION

**SECTION 10 26 00
WALL AND DOOR PROTECTION**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Corner guards.
- B. Protective wall pane.

1.02 RELATED REQUIREMENTS

- A. Section 09 22 16 - Non-Structural Metal Framing: Placement of supports in stud wall construction.

1.03 REFERENCE STANDARDS

- A. ASTM D256 - Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics; 2024.
- B. ASTM D543 - Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents; 2021.
- C. ASTM F476 - Standard Test Methods for Security of Swinging Door Assemblies; 2023.
- D. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi; 2015, with Editorial Revision (2021).

1.04 SUBMITTALS

- A. Product Data: Indicate physical dimensions, features, wall mounting brackets with mounted measurements, anchorage details, and rough-in measurements.
- B. Shop Drawings: Include plans, elevation, sections, and attachment details.
- C. Samples: Submit samples illustrating component design, configurations, joinery, color and finish.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver wall and door protection items in original, undamaged protective packaging. Label items to designate installation locations.
- B. Protect work from moisture damage.
- C. Protect work from UV light damage.
- D. Do not deliver products to project site until areas for storage and installation are fully enclosed, and interior temperature and humidity are in compliance with manufacturer's recommendations for each type of item.
- E. Store products in either horizontal or vertical position, in compliance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Protective Wall Panels: Provide as indicated on the Finish Materials Legend on the Drawings (WP-6, WP-7), see 06 64 00 Plastic Paneling.
- B. Corner guards: Refer to Drawings for manufacturer.

2.02 PERFORMANCE CRITERIA

- A. Impact Strength: Unless otherwise noted, provide protection products and assemblies that have been successfully tested for compliance with applicable provisions of ASTM D256.

- B. Chemical and Stain Resistance: Unless otherwise noted, provide protection products and assemblies with chemical and stain resistance complying with applicable provisions of ASTM D543.
- C. Fungal Resistance: Unless otherwise noted, provide protection products and assemblies which pass ASTM G21 testing.

2.03 PRODUCT TYPES

- A. Corner Guards - Surface Mounted:
 - 1. Material: Type 304 stainless steel, No. 4 finish.
 - 2. Material: Clear acrylic.
 - 3. Width of Wings: 3 inches (76 mm) and 3 inches (76 mm).
 - 4. Corner: Square.
 - 5. Color: As indicated.
 - 6. Length: One piece.
 - 7. Mounting: Adhesive.
- B. Adhesives and Primers: As recommended by manufacturer.

2.04 FABRICATION

- A. Fabricate components with tight joints, corners and seams.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that rough openings, concealed blocking, and anchors are correctly sized and located.
- B. Verify that substrate surfaces for adhered items are clean and smooth.

3.02 INSTALLATION

- A. Install components in accordance with manufacturer's instructions, level and plumb, secured rigidly in position to supporting construction.
- B. Position corner guard 4 inches (102 mm) above finished floor to ceiling or as indicated on drawings.
- C. Position protective wall covering no less than 1 inch (25.4 mm) above finished floor to allow for floor level variation.
 - 1. Apply adhesive with 1/8 inch (3.2 mm) V-notch trowel to an area of wall surface that can be completed within cure time of the adhesive.

3.03 TOLERANCES

- A. Maximum Variation From Required Height: 1/4 inch (6 mm).

3.04 CLEANING

- A. Clean wall and door protection items of excess adhesive, dust, dirt, and other contaminants.

END OF SECTION

**SECTION 10 28 00
TOILET, BATH, AND LAUNDRY ACCESSORIES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Commercial toilet accessories.
- B. Commercial shower and bath accessories.
- C. Utility room accessories.

1.02 REFERENCE STANDARDS

- A. ASTM A269/A269M - Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service; 2024.
- B. ASTM A666/A666M - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2024.
- C. ASTM C1036 - Standard Specification for Flat Glass; 2025.
- D. ASTM C1503 - Standard Specification for Silvered Flat Glass Mirror; 2024.
- E. ASTM D4802 - Standard Specification for Poly(Methyl Methacrylate) Acrylic Plastic Sheet; 2016.

1.03 SUBMITTALS

- A. Product Data: Submit data on accessories describing size, finish, details of function, and attachment methods.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Commercial Toilet Accessories:
 - 1. American Specialties, Inc.
 - 2. Bradley Corporation.
 - 3. Bobrick.

2.02 MATERIALS

- A. Accessories - General: Shop assembled, free of dents and scratches and packaged complete with anchors and fittings, steel anchor plates, adapters, and anchor components for installation.
- B. Stainless Steel Sheet: ASTM A666/A666M, Type 304.
- C. Stainless Steel Tubing: ASTM A269/A269M, Grade TP304 or TP316.
- D. Acrylic Plastic Sheet: ASTM D4802.
- E. Mirror Glass: Annealed float glass, ASTM C1036 Type I, Class 1, Quality Q2, with silvering, protective and physical characteristics complying with ASTM C1503.
- F. Fasteners, Screws, and Bolts: Hot dip galvanized; security type.

2.03 FINISHES

- A. Stainless Steel: Satin finish, unless otherwise noted.

2.04 COMMERCIAL TOILET ACCESSORIES

- A. Toilet Paper Dispenser (TPD01): Double roll, surface-mounted, stainless steel unit with pivot hinge, tumbler lock.
 - 1. Product:
 - a. Basis of Design: Bobrick B-2888.
- B. Paper Towel Dispenser (PTD01): Steel, C-Fold/M-Fold, surface mounted.
 - 1. Product:

- a. Basis of Design: Bobrick B-2620 Classic..
- C. Automated Soap Dispenser (SD01): Liquid soap dispenser, wall-mounted, with stainless steel cover and window to gauge soap level, tumbler lock.
 - 1. Minimum Capacity: 30 fl oz (850 ml).
 - 2. Product:
 - a. Bobrick B-2012.
- D. Mirror (MIR01): Glass mirror with stainless steel angle frame, 1/4 inch glass.
 - 1. Size: As indicated on drawings.
 - 2. Product:
 - a. Basis of Design: Bobrick B-290 Series.
- E. Seat Cover Dispenser (TSCD01): Stainless steel, surface mounted.
 - 1. Product:
 - a. Basis of Design: Bobrick B-221.
- F. Grab Bars (GB##): Stainless steel, smooth surface.
 - 1. Standard Duty Grab Bars:
 - a. Push/Pull Point Load: 250 pound-force (1112 N), minimum.
 - b. Dimensions: 1-1/2 inch (38 mm) outside diameter, minimum 0.05 inch (1.3 mm) wall thickness, concealed flange mounting.
 - c. Finish: Satin.
 - d. Length and Configuration: As indicated on drawings.
 - e. Products:
 - 1) Basis of Design: Bobrick B-6806 Series.
- G. Combination Sanitary Napkin/Tampon Dispenser (SNTD01): Stainless steel, recessed.
 - 1. Door: Seamless 0.05 inch (1.3 mm) door with returned edges and tumbler lock.
 - 2. Cabinet: Fully welded, 0.03 inch (0.8 mm) thick sheet.
 - 3. Product:
- H. Sanitary Napkin Disposal Unit (SND01): Stainless steel, surface-mounted, self-closing door, locking bottom panel with full-length stainless steel piano-type hinge, removable receptacle.
 - 1. Product:
 - a. Basis of Design: B-270.

2.05 COMMERCIAL SHOWER AND BATH ACCESSORIES

- A. Robe/Coat Hook: Heavy-duty stainless steel, single-prong, bracket and backplate for concealed attachment, satin finish.
 - 1. Product:
 - a. Basis of Design: Bobrick B-9542.

2.06 UTILITY ROOM ACCESSORIES

- A. Mop and Broom Holder: 0.05 inch (1.3 mm) thick stainless steel, Type 304, hat-shaped channel.
 - 1. Holders: Three spring-loaded rubber cam holders.
 - 2. Length: 36 inches (900 mm).
 - 3. Product:
 - a. Basis of Design: Bobrick B-224.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify exact location of accessories for installation.

3.02 PREPARATION

- A. Deliver inserts and rough-in frames to site for timely installation.
- B. Provide templates and rough-in measurements as required.

3.03 INSTALLATION

- A. Install accessories in accordance with manufacturers' instructions in locations indicated on drawings.
- B. Install plumb and level, securely and rigidly anchored to substrate.
- C. Mounting Heights: As required by accessibility regulations, unless otherwise indicated.

3.04 PROTECTION

- A. Protect installed accessories from damage due to subsequent construction operations.

END OF SECTION

**SECTION 10 44 00
FIRE PROTECTION SPECIALTIES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Fire extinguishers.
- B. Fire extinguisher cabinets.
- C. Accessories.

1.02 REFERENCE STANDARDS

- A. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems; 2024.
- B. NFPA 10 - Standard for Portable Fire Extinguishers; 2022.

1.03 SUBMITTALS

- A. Product Data: Provide extinguisher operational features, extinguisher ratings and classifications, color and finish, and anchorage details.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Fire Extinguishers:
 - 1. Activar Construction Products Group, Inc. - JL Industries; Cosmic Extinguisher - Multipurpose Chemical: www.activarcpg.com/#sle.
 - 2. Nystrom, Inc: www.nystrom.com/#sle.
 - 3. Potter-Roemer: www.potterroemer.com/#sle.
 - 4. Larsen's Manufacturing.
 - 5. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Fire Extinguisher Cabinets and Accessories:
 - 1. Activar Construction Products Group, Inc. - JL Industries; Ambassador Series No. 1015-V-17: www.activarcpg.com/#sle.
 - 2. Nystrom, Inc: www.nystrom.com/#sle.
 - 3. Potter-Roemer: www.potterroemer.com/#sle.
 - 4. Larsen's Manufacturing.
 - 5. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 FIRE EXTINGUISHERS

- A. Fire Extinguishers - General: Comply with product requirements of NFPA 10 and applicable codes, whichever is more stringent.
- B. Multipurpose Dry Chemical Type Fire Extinguishers: Carbon steel tank, with pressure gauge.
 - 1. Class: A:B:C type.
 - 2. Size: 10 pound (4.54 kg).

2.03 FIRE EXTINGUISHER CABINETS

- A. Fire Rating: Listed and labeled in accordance with ASTM E814 requirements for fire resistance rating of walls where being installed.
- B. Cabinet Construction: Non-fire rated.
 - 1. Formed primed steel sheet; 0.036 inch (0.9 mm) thick base metal.
- C. Fire Rated Cabinet Construction: One-hour fire rated.
- D. Cabinet Configuration: Recessed type.
- E. Door: Stainless steel contemporary V-panel door style with glass.

- F. Door Glazing: Tempered safety glass, clear, 1/8 inch (3 mm) thick, and set in resilient channel glazing gasket.
- G. Latch: Magnetic catch.

2.04 KEY VAULTS

- A. Knox box.
- B. Finish of Cabinet Exterior Trim and Door: Powder-coat finish in color as selected by Architect from manufacturer's standard colors..

2.05 ACCESSORIES

- A. Extinguisher Brackets: Formed steel, galvanized and enamel finished.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify rough openings for cabinet are correctly sized and located.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install cabinets plumb and level in wall openings.

END OF SECTION

**SECTION 11 30 13
RESIDENTIAL APPLIANCES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Kitchen appliances.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 83 - Wiring Connections: Electrical connections for appliances.

1.03 REFERENCE STANDARDS

- A. UL (DIR) - Online Certifications Directory; Current Edition.

1.04 SUBMITTALS

- A. Product Data: Manufacturer's data indicating dimensions, capacity, and operating features of each piece of residential equipment specified.
- B. Copies of Warranties: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.05 QUALITY ASSURANCE

- A. Electric Appliances: Listed and labeled by UL (DIR) and complying with NEMA Standards (National Electrical Manufacturers Association).

1.06 WARRANTY

- A. Provide five (5) year manufacturer warranty on refrigeration system of refrigerators.

PART 2 PRODUCTS

2.01 KITCHEN APPLIANCES

- A. Provide Equipment Eligible for Energy Star Rating: Energy Star Rated, as scheduled on the drawings.
- B. Undercounter Refrigerator: Free-standing
 1. Capacity: 5.6 cu. ft.
 2. Energy Usage: Minimum 20 percent more energy efficient than energy efficiency standards set by U.S. Department of Energy (DOE).
 3. Exterior Finish: Stainless steel.
 4. Manufacturers:
 - a. Frigidaire Home Products: www.frigidaire.com/#sle.
 - b. GE Appliances; 5.6 cu. ft. Mini Fridge in Stainless Steel: www.geappliances.com/#sle.
 - c. Whirlpool Corp: www.whirlpool.com/#sle.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.

3.02 CLEANING

- A. Remove packing materials from equipment and properly discard.
- B. Wash and clean equipment.

END OF SECTION

**SECTION 12 24 00
WINDOW SHADES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Interior manual roller shades.
- B. Interior motorized roller shades.

1.02 REFERENCE STANDARDS

- A. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi; 2015, with Editorial Revision (2021).
- B. NFPA 701 - Standard Methods of Fire Tests for Flame Propagation of Textiles and Films; 2023, with Errata.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Convene one week prior to commencing work related to products of this section; require attendance of affected installers.

1.04 SUBMITTALS

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets, including materials, finishes, fabrication details, dimensions, profiles, mounting requirements, and accessories.
- B. Shop Drawings: Include shade schedule indicating size, location and keys to details and head, jamb and sill details.
- C. Verification Samples: Minimum size 6 inches (150 mm) square, representing actual materials, color and pattern.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing work of this type with minimum three years of experience with shading systems of similar size and type.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver shades in manufacturer's unopened packaging, labeled to identify each shade for each opening.
- B. Handle and store shades in accordance with manufacturer's recommendations.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Interior Roller Shades:
 - 1. Basis of Design: As indicated on Finish Materials Legend on the Drawings.

2.02 ROLLER SHADES

- A. General:
 - 1. Provide shade system components that are easy to remove or adjust without removal of mounted shade brackets.
 - 2. Provide shade system that operates smoothly when shades are raised or lowered.
- B. Roller Shades (WT-1, WT-2, WT-3):
 - 1. Description - Interior Roller Shades: Single roller, motor and manually operated fabric window shade system complete with mounting brackets, roller tubes, hembars, hardware, and accessories.
 - a. Fabric: As indicated under the Shade Fabric article and on the Finish Materials Legend on the Drawings.

2. Brackets and Mounting Hardware: As recommended by manufacturer for mounting indicated and to accommodate shade fabric roll-up size and weight.
3. Roller Tubes: As required for type of shade operation.
4. Hembars: Designed to maintain bottom of shade straight and flat.
5. Manual Operation for Interior Shades:
 - a. Clutch Operator: Manufacturer's standard material and design, permanently lubricated.
 - b. Drive Chain: Continuous loop beaded ball chain, 95 lb (43 kg) minimum breaking strength. Provide upper and lower limit stops.
6. Accessories:
 - a. Fascia: Extruded aluminum, size as required to conceal shade mounting, attachable to brackets without exposed fasteners; clear anodized finish.
 - b. Blockout with Side Channels for room darkening.
 - 1) Aluminum side channels, sill channels, bottom bar, fitted with light-blocking wool pile to prevent light leakage around edges and bottom of shade.

2.03 SHADE FABRIC

- A. Fabric: Nonflammable, color-fast, impervious to heat and moisture, and able to retain its shape under normal operation.
 1. Material: Vinyl coated polyester.
 2. Performance Requirements:
 - a. Flammability: Pass NFPA 701 large and small tests.
 - b. Fungal Resistance: No growth when tested according to ASTM G21.

2.04 ROLLER SHADE FABRICATION

- A. Field measure finished openings prior to ordering or fabrication.
- B. Dimensional Tolerances: Fabricate shades to fit openings within specified tolerances.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions and approved shop drawings, using mounting devices as indicated.
- B. Adjust level, projection, and shade centering from mounting bracket. Verify there is no telescoping of shade fabric. Ensure smooth shade operation.

3.02 CLEANING

- A. Clean soiled shades and exposed components as recommended by manufacturer.
- B. Replace shades that cannot be cleaned to "like new" condition.

3.03 CLOSEOUT ACTIVITIES

- A. Demonstration: Demonstrate operation and maintenance of window shade system to Owner's personnel.

3.04 PROTECTION

- A. Protect installed products from subsequent construction operations.

END OF SECTION

**SECTION 12 36 00
COUNTERTOPS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Countertops for architectural cabinet work.
- B. Window sills.
- C. Wall-hung counters and vanity tops.

1.02 RELATED REQUIREMENTS

- A. Section 06 41 00 - Architectural Wood Casework.
- B. Section 22 40 00 - Plumbing Fixtures: Sinks.

1.03 REFERENCE STANDARDS

- A. ANSI A208.1 - American National Standard for Particleboard; 2022.
- B. ANSI A208.2 - Medium Density Fiberboard (MDF) for Interior Applications; 2022.
- C. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2024.
- D. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards, 2nd Edition; 2014, with Errata (2016).
- E. AWMAC/WI (NAAWS) - North American Architectural Woodwork Standards; 2021, with Errata.
- F. ISFA 2-01 - Classification and Standards for Solid Surfacing Material; 2013.
- G. NEMA LD 3 - High-Pressure Decorative Laminates; 2005.
- H. PS 1 - Structural Plywood; 2023.

1.04 SUBMITTALS

- A. Product Data: Manufacturer's data sheets on each product to be used, including:
 - 1. Preparation instructions and recommendations.
 - 2. Storage and handling requirements and recommendations.
 - 3. Specimen warranty.
- B. Shop Drawings: Complete details of materials and installation; combine with shop drawings of cabinets and casework specified in other sections.
- C. Verification Samples: For each finish product specified, minimum size 6 inches (150 mm) square, representing actual product, color, and patterns.
- D. Certificate: Submit labels and certificates required by quality assurance and quality control programs.
- E. Maintenance Data: Manufacturer's instructions and recommendations for maintenance and repair of countertop surfaces.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing work of the type specified in this section, with not less than three years of experience.
- B. Quality Certification:
 - 1. Provide labels or certificates indicating that the installed work complies with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS) requirements for grade or grades specified.
 - 2. Provide designated labels on shop drawings as required by certification program.
 - 3. Provide designated labels on installed products as required by certification program.

4. Submit certifications upon completion of installation that verifies this work is in compliance with specified requirements.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.07 FIELD CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

PART 2 PRODUCTS

2.01 COUNTERTOPS

- A. Quality Standard: Custom Grade, in accordance with AWI/AWMAC/WI (AWS), unless noted otherwise.
- B. Solid Surfacing Countertops (SSM-1): Solid surfacing sheet or plastic resin casting over continuous substrate.
 1. Flat Sheet Thickness: 1/2 inch (12 mm), minimum; as indicated on the drawings
 2. Solid Surfacing Sheet and Plastic Resin Castings: Complying with ISFA 2-01 and NEMA LD 3; acrylic or polyester resin, mineral filler, and pigments; homogenous, non-porous and capable of being worked and repaired using standard woodworking tools; no surface coating; color and pattern consistent throughout thickness.
 - a. Manufacturers:
 - 1) Basis of Design: Provide per the Finish Materials Legend on the Drawings or an equal product one of the following:
 - 2) Avonite Surfaces: www.avonitesurfaces.com/#sle.
 - 3) Dupont: www.corian.com/#sle.
 - 4) Wilsonart: www.wilsonart.com/#sle.
 - b. Surface Burning Characteristics: Flame spread index of 25, maximum; smoke developed index of 450, maximum; when tested in accordance with ASTM E84.
 - c. Finish on Exposed Surfaces: Matte, gloss rating of 5 to 20.
 - d. Color and Pattern: Per the Finish Materials Legend on the Drawings.
 3. Other Components Thickness: 1/2 inch (12 mm), minimum.
 4. Exposed Edge Treatment: Built up to minimum 1-1/4 inch (32 mm) thick; square edge; use marine edge at sinks.
 5. Back and End Splashes: Same sheet material, square top; minimum 4 inches (102 mm) high.
 6. Fabricate in accordance with AWI/AWMAC/WI (AWS), Section 11 - Countertops, Premium Grade.

2.02 MATERIALS

- A. Plywood for Supporting Substrate: PS 1 Exterior Grade, A-C veneer grade, minimum 5-ply; minimum 3/4 inch (19 mm) thick; join lengths using metal splines.
- B. Particleboard for Supporting Substrate: ANSI A208.1 Grade 2-M-2, 45 pcf (20 kg/cu m) minimum density; minimum 3/4 inch (19 mm) thick; join lengths using metal splines.
- C. Medium Density Fiberboard for Supporting Substrate: ANSI A208.2.
- D. Adhesives: Chemical resistant waterproof adhesive as recommended by manufacturer of materials being joined.
- E. Joint Sealant: Mildew-resistant silicone sealant, white.

2.03 ACCESSORIES

- A. Fixed Top-Mounted Countertop Support Brackets:
 - 1. Material: Steel.
 - 2. Finish: Manufacturer's standard, factory-applied, textured powder coat.
 - 3. Color: As selected by the Architect from manufacturer's standard colors..
 - 4. Basis-of-Design Manufacturer: A & M Hardware.
 - 5. Capacity: 1,000 pounds minimum.

2.04 FABRICATION

- A. Fabricate tops and splashes in the largest sections practicable, with top surface of joints flush.
 - 1. Join lengths of tops using best method recommended by manufacturer.
 - 2. Fabricate to overhang fronts and ends of cabinets 1 inch (25 mm) except where top butts against cabinet or wall.
 - 3. Prepare all cutouts accurately to size; replace tops having improperly dimensioned or unnecessary cutouts or fixture holes.
- B. Provide back/end splash wherever counter edge abuts vertical surface unless otherwise indicated.
 - 1. Secure to countertop with concealed fasteners and with contact surfaces set in waterproof glue.
 - 2. Height: 4 inches (102 mm), unless otherwise indicated.
- C. Solid Surfacing: Fabricate tops and window sills up to 144 inches (3,657 mm) long in one piece; join pieces with adhesive sealant in accordance with manufacturer's recommendations and instructions.
- D. Wall-Mounted Counters: Provide skirts, aprons, brackets, and braces as indicated on drawings, finished to match.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
- C. Verify that wall surfaces have been finished and mechanical and electrical services and outlets are installed in proper locations.

3.02 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.03 INSTALLATION

- A. Securely attach countertops to cabinets using concealed fasteners. Make flat surfaces level; shim where required.
- B. Seal joint between back/end splashes and vertical surfaces.

3.04 TOLERANCES

- A. Variation From Horizontal: 1/8 inch in 10 feet (3 mm in 3 m), maximum.
- B. Offset From Wall, Countertops: 1/8 inch (3 mm) maximum; 1/16 inch (1.5 mm) minimum.
- C. Field Joints: 1/8 inch (3 mm) wide, maximum.

3.05 CLEANING

- A. Clean countertops surfaces thoroughly.

3.06 PROTECTION

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Date of Substantial Completion.

END OF SECTION

**SECTION 20 00 00
GENERAL MECHANICAL REQUIREMENTS**

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This specification section is intended to act as a supplement to Division 01 of the project manual. In the instance that this project includes a Division 01, the requirements therein supersede the requirements of this section, except the requirements for coordination amongst the divisions as stated below. If the project manual does not address requirements included below, this section prevails.
- B. It is intended for the Division 20, 21, 22, 23 scope of work to include complete and functional systems - including all required materials, labor, equipment, and services necessary to achieve the desired final product. It is further intended for the Division 20 scope of work to include coordination with Divisions 21 and 22 and Division 23 for complete functional Fire Protection, Plumbing and HVAC systems without excessive noise and vibration.
- C. These specifications and accompanying drawings are intended to communicate the design concept for this project and outline the scope of work. They should not be viewed as a comprehensive document that details every specific task, item, or piece of equipment required to complete the project.
- D. It is understood that industry knowledge and experience is required to establish an accurate and complete scope of work from these documents, and it is assumed that the Division 20, 21, 22, 23 Contractors possess that knowledge and experience.
- E. Work not specifically noted in these specifications or the accompanying drawings, but which is required to complete the project, shall be included by the Division 20, 21, 22, 23 Contractors as part of their scope of work.
- F. These specifications and the accompanying drawings are the "contract documents", intended to supplement each other. Information included in either one shall be incorporated into the project as if included in both. In the event of any conflicts, the most stringent requirements shall be considered the governing scope of work until and unless clarification can be obtained by the Contractor.
- G. In the event of dimensional discrepancies between Division 20, 21, 22, 23 documents and other disciplines, Architectural and Structural documents take precedence over Division 20, 21, 22, 23. Refer to this information for sufficient understanding to the extent that it impacts the Division 20, 21, 22, and 23 scope of work.
- H. Drawings are intended to indicate the general arrangement of piping, ductwork, equipment and other components of Division 20, 21, 22, 23 systems. They shall be followed as closely as possible, but shall be considered diagrammatic in nature. They are not intended to show every component, fitting, offset, etc. Components, fittings, offsets, etc. as required to meet the intent of the documents and to achieve coordination with other trades shall be included in the Division 20, 21, 22, 23 scope of work. Note that more detailed information about routing may be provided for certain areas of the project where special constraints exist. It is the intent of this detailed information to better communicate the constraints, but these drawings and details shall still be considered diagrammatic in nature as outlined above.
- I. Routing and Locations
 - 1. It is the Contractor's responsibility to coordinate equipment locations and system routing with available space and with all other trades.
 - 2. It is the Contractor's responsibility to coordinate and verify the exact locations and routing of equipment and systems prior to fabrication and installation. If discrepancies become apparent as part of the verification process, the Contractor shall ask for written clarification/direction. Alteration, removal and/or replacement of work already installed as

a result of failure to verify and/or coordinate locations and routing prior to fabrication and/or installation shall be at the Contractor's expense.

3. Locations of equipment shown on the drawings are approximate unless specifically dimensioned.
4. All ductwork, piping, tubing, conduit, etc. shall be concealed within building construction unless noted otherwise. Mechanical rooms are considered to be within building construction for the purposes of this requirement.
5. Existing utilities, piping, and ductwork have been indicated as closely as possible. The Contractor can assume that points of connection to existing utilities have been shown within 10 feet (3 meters) of the actual location. When actual points of connection are more than 10 feet (3 meters) from the location shown on the drawings, the Contractor shall notify the Owner's Representative prior to commencing this portion of the work.
6. The Contractor is responsible for any remedial work required from failure to locate and preserve underground utilities. This shall include all work necessary to repair any damaged utilities to their original condition.

J. Scheduling

1. It is understood that while drawings are to be followed as closely as circumstances permit, the Contractor shall be responsible for installation of systems according to the true intent and meaning of Contract Documents. Anything not clear or in conflict will be explained by making application to Owner's Representative. The Contractor shall familiarize himself with his scope of work as well as the required coordination with other trades and the scheduling of other trades sufficiently to address coordination issues in a timely manner such that they do not result in remedial work for other trades.
2. Should conditions arise where certain changes would be advisable, secure approval from Owner's Representative for those changes before proceeding with work. Proceeding without written approval is at the Contractor's risk and at the Contractor's expense.
3. The Contractor shall coordinate with the work of various trades when installing interrelated work. Before installation of mechanical items, proper provisions shall be made to avoid interferences. Changes required in work specified in Division 20, 21, 22, 23 caused by neglect to do so shall be made at no cost to Owner.
4. Inserts and supports required by Division 20, 21, 22, 23 shall be furnished and installed unless otherwise noted. Furnish sleeves, inserts, supports, and equipment that are an integral part of other Divisions of the Work to those involved in sufficient time to be built into construction as the Work proceeds. Locate these items and see that they are properly installed. Expense resulting from improper location or installation of items above shall be borne under Division 20, 21, 22, 23.

K. Cutting and Patching

1. The Division 20, 21, 22, 23 Contractor shall be responsible for all cutting and patching required to complete the Division 20, 21, 22, 23 scope of work.
2. All patching shall be performed such that it matches existing finishes.
3. The Contractor shall not cut any structural members without first getting approval from the Owner's Representative to do so.
4. All cutting and patching required to correct defective or otherwise unacceptable work shall be the responsibility of the Division 20, 21, 22, 23 Contractor.

L. Guarantee

1. All Division 20, 21, 22, 23 systems and equipment shall be guaranteed for a minimum period of one year.
2. Specific equipment and/or systems requiring warranties beyond one year are indicated in the table at the end of this section and/or within individual Division 21, 22 and 23 specification sections.
3. The guarantee shall begin at the Date of Acceptance, unless written documentation is provided noting otherwise. When more than one Date of Acceptance is indicated for

various portions or specific equipment, the guarantee shall begin at the Date of Acceptance independently for each portion of the system or piece of equipment.

4. Permission to use Division 20, 21, 22, 23 systems or equipment for temporary heating or other contractor use prior to the Date of Acceptance, as outlined elsewhere in these specifications, shall not constitute the beginning of the guarantee period. The contractor shall make any necessary arrangements to extend equipment and/or system warranties sufficient to maintain the designated guarantee period from the Date of Acceptance.
5. Exception: When temporary heating and or other system use is requested by the Owner for the Owner's benefit prior to the Date of Acceptance, the guarantee period for the portions of the system or specific equipment requested for use may begin at the time it is put into service. This can only be assumed to have occurred if written documentation is provided indicating such.

1.02 GENERAL REFERENCES

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.
- B. Contract Documents: Refer to complete set of Contract Documents for requirements that are related to or may affect the work described in this Section.

1.03 RELATED REQUIREMENTS

- A. Division 01 "Payment Procedures" for submitting Applications for Payment and the schedule of values.
- B. Division 01 "Project Management and Coordination" for submitting coordination drawings and subcontract list and for requirements for web-based Project software.
- C. Division 01 "Construction Progress Documentation" for submitting schedules and reports, including Contractor's construction schedule.
- D. Division 01 "Photographic Documentation" for submitting preconstruction photographs, periodic construction photographs, and final completion construction photographs.

1.04 REFERENCE STANDARDS

- A. 10 CFR 430 - Energy Conservation Program for Consumer Products; Current Edition.
- B. ASME B31.9 - Building Services Piping; 2020.
- C. NFPA 10 - Standard for Portable Fire Extinguishers; 2022.
- D. NFPA 12 - Standard on Carbon Dioxide Extinguishing Systems; 2025.
- E. NFPA 12A - Standard on Halon 1301 Fire Extinguishing Systems; 2025.
- F. NFPA 13 - Standard for the Installation of Sprinkler Systems; 2022.
- G. NFPA 14 - Standard for the Installation of Standpipe and Hose Systems; Approved Edition.
- H. NFPA 55 - Compressed Gases and Cryogenic Fluids Code; 2023, with Amendment .
- I. NFPA 80 - Standard for Fire Doors and Other Opening Protectives; 2025.
- J. NFPA 82 - Standard on Incinerators and Waste and Linen Handling Systems and Equipment; 2019.
- K. NFPA 85 - x; x.
- L. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2024.
- M. NFPA 101 - Life Safety Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- N. NFPA 770 - Standard on Hybrid (Water and Inert Gas) Fire-Extinguishing Systems; 2021.
- O. NFPA 2001 - Standard on Clean Agent Fire Extinguishing Systems; 2025.

- P. References to industry standards, testing procedures, etc. are noted in individual sections of these specifications. The requirements and standards from the referenced documents shall be considered part of the requirements of these specifications.

1.05 APPLICABLE CODES AND STANDARDS

- A. Division 20, 21, 23, 23 work shall be performed in accordance with applicable codes and standards as adopted by the Authorities Having Jurisdiction including amendments.
- B. Following is a listing of major codes and standards, the requirements of which shall be considered part of the scope of this project. This list should not be considered comprehensive, and codes or standards not included in this list should not be excluded from the scope of the project.
1. Local Codes and Ordinances
 - a. Local Building Code
 - b. Local Plumbing Code
 - c. Local Fire Code
 - d. Local Safety Authority Safety Standards Act
 - e. Local Safety Authority Power Engineers, Boiler, Pressure Vessel, and Refrigeration Safety Regulation
 - f. Local Amendment to Canadian Electrical Code
 - g. Local Electrical Safety Regulation
 - h. Local Electrical Safety Branch Bulletins
 - i. Local Elevating Devices Safety Regulation
 - j. Local Gas Safety Regulation
 - k. Local Code Amendments, Gas Safety Act & Regulations
 - l. Local Occupational Health & Safety (OHS) Regulations
 - m. Local Safety Standards Act
 2. ANSI/ASME Codes & Standards
 - a. ASME B31.1 Power Piping
 - b. ASME/ASME B31.9 Building Services Piping
 - c. ASME B31E Standard for the Seismic Design and Retrofit of Above-Ground Piping Systems, Includes Addenda A
 - d. ASME/ANSI A13.1-23 Scheme for the Identification of Piping Systems
 3. National Fire Protection Association
 - a. NFPA 10 Standard for Portable Fire Extinguishers
 - b. NFPA 11 Standard for Low, Medium, and High Expansion Foam
 - c. NFPA 12 Standard on Carbon Dioxide Extinguishing Systems
 - d. NFPA 12A Standard on Halon 1301 Fire Extinguishing Systems
 - e. NFPA 13 Standard for the Installation of Sprinkler Systems
 - f. NFPA 14 Standard for the Installation of Standpipe and Hose Systems
 - g. NFPA 17 Standard on Dry Chemical Extinguishing Systems
 - h. NFPA 20 Standard for the Installation of Stationary Pumps for Fire Protection
 - i. NFPA 22 Standard for Water Tanks for Private Fire Protection.
 - j. NFPA 24 Standard for the Installation of Private Fire Service Mains and their Appurtenances
 - k. NFPA 30 Flammable and Combustible Liquids Code
 - l. NFPA 55 Compressed Gases and Cryogenic Fluids Code
 - m. NFPA 68 Standard on Explosion Protection by Deflagration Venting
 - n. NFPA 69 Standard on Explosion Prevention Systems.
 - o. NFPA 70 National Electrical Code.
 - p. NFPA 72 National Fire Alarm and Signaling Code.
 - q. NFPA 80 Standard for Fire Doors and Other Opening Protectives

- r. NFPA 82 Standard on Incinerators and Waste and Linen Handling Systems and Equipment
- s. NFPA 85 Boiler and Combustion Systems Hazards Code
- t. NFPA 90A Standard for the Installation of AirConditioning and Ventilating Systems
- u. NFPA 101 Life Safety Code
- 4. SMACNA Publications
 - a. SMACNA 001 Guidelines for seismic restraints of mechanical systems
 - b. SMACNA 002 Rectangular Industrial Duct Construction Standards
 - c. SMACNA 005 Round Industrial Duct Construction Standards
 - d. SMACNA 006 HVAC Duct Construction Standards, Metal and Flexible
 - e. SMACNA 008 IAQ Guidelines for Occupied Buildings Under Construction
 - f. SMACNA 012 HVAC Air Duct Leakage Test Manual
 - g. SMACNA 014 HVAC Systems Commissioning Manual
 - h. SMACNA Fire, Smoke, and Radiation Damper Installation Guide
- 5. ASHRAE Standards
 - a. ASHRAE Standard 34 Designation and Safety Classification of Refrigerants
 - b. ASHRAE Standard 62.1 Ventilation for Acceptable Indoor Air Quality
 - c. ASHRAE/IES Standard 90.1 Energy Standard for Buildings Except Low-Rise Residential Buildings
 - d. ASHRAE/SMACNA Standard 126 Method of Testing HVAC Air Ducts
 - e. ASHRAE Standard 202 The Commissioning Process for Buildings and Systems.
 - f. ASHRAE/NIBS Guideline 0 The Commissioning Process
 - g. ASHRAE Guideline 1.1 HVAC&R Technical Requirements For The Commissioning Process
 - h. ASHRAE Guideline 1.3 Building Operations and Maintenance Training for The HVAC&R Commissioning Process
 - i. ASHRAE Guideline 1.4 Procedures for Preparing Facility Systems Manuals
- 6. NSF
 - a. NSF/ANSI/CAN 61 Drinking Water System Components - Health Effects
 - b. NSF/ANSI/CAN 372 Drinking Water System Components - Lead Content
- 7. United States
 - a. Americans with Disabilities Act (ADA)
 - b. National Electrical Code
 - c. International Building Code
 - d. International Fire Code
 - e. International Mechanical Code
 - f. Uniform Plumbing Code

1.06 ABBREVIATIONS AND ACRONYMS

- A. The following are industry abbreviations used in these specifications:
 - 1. ABS: Acrylonitrile-butadiene-styrene plastic
 - 2. AHJ: Authority Having Jurisdiction
 - 3. ASJ: All-service jacket
 - 4. BAS: Building automation system
 - 5. BR: Butyl rubber; Buna-N: Nitrile rubber
 - 6. CPVC: Chlorinated polyvinyl chloride plastic
 - 7. CR: Chlorosulfonated polyethylene synthetic rubber
 - 8. CSM: Chlorosulfonyl-polyethylene rubber
 - 9. CWP: Cold working pressure
 - 10. DDC: Direct digital control
 - 11. DOP: Dioctyl phthalate or bis-(2-ethylhexyl) phthalate
 - 12. EMCS: Energy Management and Control System

13. EMS: Energy Management System consisting of BAS (typically with a PC and support software), DDC controllers, and networking software/hardware/wiring.
14. EPDM: Ethylene-propylene-diene terpolymer rubber
15. FRP: Fiberglass-reinforced plastic
16. FSK: Foil, scrim, kraft paper
17. FSP: Foil, scrim, polyethylene
18. HDPE: High-density polyethylene plastic
19. HEPA: High-efficiency particulate air
20. I/O: Input/output
21. LLDPE: Linear, low-density polyethylene plastic
22. MS/TP: Master slave/token passing
23. MSS: Manufacturers Standardization Society for The Valve and Fittings Industry Inc
24. NBR: Acrylonitrile-butadiene rubber
25. NC: Noise criteria; NR: Natural rubber
26. NUSIG: National Uniform Seismic Installation Guidelines
27. PE: Polyethylene plastic
28. PEX: Crosslinked polyethylene plastic
29. PC: Personal computer
30. PID: Proportional plus integral plus derivative
31. PMMA: Polymethyl methacrylate (acrylic) plastic
32. PP: Polypropylene plastic
33. PTFE: Polytetrafluoroethylene plastic
34. PUR: Polyurethane plastic
35. PVC: Polyvinyl chloride plastic
36. PVDC: Polyvinylidene chloride
37. RC: Room criteria
38. RTD: Resistance temperature detector
39. SSL: Self-sealing lap
40. SWP: Steam working pressure
41. TFE: Tetrafluoroethylene plastic
42. TPE: Thermoplastic elastomer
43. ULPA: Ultra low penetration air

1.07 DEFINITIONS

- A. The following definitions shall apply to the use of these words when used in Division 20, 21, 22, 23. These definitions are not intended to define use of these words outside of Division 20, 21, 22, 23.
 1. Acceptance: The Owner's assumption of ownership of the Mechanical systems installation.
 2. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
 3. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.
 4. Contractor (The Contractor, This Contractor, Division 20, 21, 22, 23 Contractor, etc.): The contractor responsible for the Division 20, 21, 22, 23 scope of work.
 5. Date of Acceptance: The official date when Acceptance occurs. This will coincide with the granting of Substantial Completion unless noted otherwise by the Owner's Representative. It shall not be assumed that the Date of Acceptance has deviated from Substantial Completion unless written documentation is provided by the owner's representative indicating differently.
 6. Electrical: Shall be considered interchangeable with "Division 26, 27, 28".

7. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
8. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
9. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
10. Mechanical: Shall be considered interchangeable with "Division 20, 21, 22, 23".
11. The primary consultant or their designated representative, as outlined in the General Conditions.
12. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.
 - a. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.
 - b. Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required in order to meet other Project requirements but may offer advantage to Contractor or Owner.
13. System: An organized collection of parts, equipment, or subsystems united by regular interaction.
14. Subsystem: A portion of a system with characteristics similar to a system.
15. Experienced: When used with an entity or individual, "experienced" unless otherwise further described means having successfully completed a minimum of five previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.
16. Field Quality-Control Tests: Tests and inspections that are performed on-site for installation of the Work and for completed Work.
17. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, assembly, and similar operations.
 - a. Use of trade-specific terminology in referring to a trade or entity does not require that certain construction activities be performed by accredited or unionized individuals, or that requirements specified apply exclusively to specific trade(s).
18. Mockups: Full-size physical assemblies that are constructed on-site either as freestanding temporary built elements or as part of permanent construction. Mockups are constructed to verify selections made under Sample submittals; to demonstrate aesthetic effects and qualities of materials and execution; to review coordination, testing, or operation; to show interface between dissimilar materials; and to demonstrate compliance with specified installation tolerances. Mockups are not Samples. Unless otherwise indicated, approved mockups establish the standard by which the Work will be judged.
 - a. Laboratory Mockups: Full-size physical assemblies constructed and tested at testing facility to verify performance characteristics.
 - b. Integrated Exterior Mockups: Mockups of the exterior envelope constructed on-site as freestanding temporary built elements or as part of permanent construction, consisting of multiple products, assemblies, and subassemblies.
 - c. Room Mockups: Mockups of typical interior spaces complete with wall, floor, and ceiling finishes; doors; windows; millwork; casework; specialties; furnishings and equipment; and lighting.
19. Preconstruction Testing: Tests and inspections performed specifically for Project before products and materials are incorporated into the Work, to verify performance or compliance with specified criteria.

20. Product Tests: Tests and inspections that are performed by a nationally recognized testing laboratory (NRTL) according to 29 CFR 1910.7, by a testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program (NVLAP), or by a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.
21. Source Quality-Control Tests: Tests and inspections that are performed at the source; for example, plant, mill, factory, or shop.
22. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.
23. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.
24. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Contractor's quality-control services do not include contract administration activities performed by Engineer or Construction Manager.
25. Alternate: An amount proposed by bidders and stated on the Bid Form for certain work defined in the bidding requirements that may be added to or deducted from the base bid amount if the Owner decides to accept a corresponding change either in the amount of construction to be completed or in the products, materials, equipment, systems, or installation methods described in the Contract Documents.
26. Alternates described in this Section are part of the Work only if enumerated in the Agreement.
 - a. The cost or credit for each alternate is the net addition to or deduction from the Contract Sum to incorporate alternates into the Work. No other adjustments are made to the Contract Sum.
27. Schedule of Values: A statement furnished by Contractor allocating portions of the Contract Sum to various portions of the Work and used as the basis for reviewing Contractor's Applications for Payment.

1.08 SUBMITTALS

A. General

1. The Contractor is responsible for identifying all required submittals throughout these specifications and following the required procedures for each type of submittal.

B. Action Submittals

1. Action Submittals: Written and graphic information and physical samples that require Engineer's and Construction Manager's responsive action. Action submittals are those submittals indicated in individual Specification Sections as "action submittals."
2. Deviations and Additional Information: On each submittal, clearly indicate deviations from requirements in the Contract Documents, including minor variations and limitations; include relevant additional information and revisions, other than those requested by Engineer on previous submittals. Indicate by highlighting on each submittal or noting on attached separate sheet.
3. PDF Submittals: Prepare submittals as PDF package, incorporating complete information into each PDF file. Name PDF file with submittal number
4. Submittal Procedures:
 - a. Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.
 - 1) Coordination: Coordinate preparation and processing of submittals with performance of construction activities.
 - 2) Engineer reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.

- b. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Engineer's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.
 - 1) Initial Review: Allow 15 business days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Engineer will advise Contractor when a submittal being processed must be delayed for coordination.
 - 2) Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.
 - 3) Resubmittal Review: Allow 15 business days for review of each resubmittal.
 - (a) Make resubmittals in same form and number of copies as initial submittal.
 - (b) A maximum of two re-submittals shall be reviewed by the Engineer. The Owner shall be entitled to deduct from the Contractors Contract Sum, amounts paid to Engineer to review more than the noted quantity of resubmittals.
- c. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.
 - 1) Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
 - (a) Identification of products.
 - (b) Schedules.
 - (c) Compliance with specified standards.
 - (d) Notation of coordination requirements.
 - (e) Notation of dimensions established by field measurement.
 - (f) Relationship and attachment to adjoining construction clearly indicated.
 - (g) Seal and signature of professional engineer if specified.
 - 2) Electronic Format or PDF Sheet Size: Except for templates, patterns and similar full-size drawings, submit Shop Drawings formatted to be plotted on sheets at least 8-1/2 by 11 inches (215 by 280 mm), but no larger than size of Contract Drawings.
- d. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other materials.
 - (a) Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other materials.
 - 2) Transmit Samples that contain multiple, related components such as accessories together in one submittal package.
 - 3) Identification: Permanently attach label on unexposed side of Samples that includes the following:
 - (a) Project name and submittal number.
 - (b) Generic description of Sample.
 - (c) Product name and name of manufacturer.
 - (d) Sample source.
 - (e) Number and title of applicable Specification Section.
 - (f) Specification paragraph number and generic name of each item.
 - 4) Email Transmittal: Provide PDF transmittal. Include digital image file illustrating Sample characteristics, and identification information for record.
 - 5) Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.

- 6) Samples for Verification: Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.
 - (a) Number of Samples: Submit three sets of Samples. Engineer will retain two Sample sets; remainder will be returned. Mark up and retain one returned Sample set as a project record Sample.
- e. Product Schedule: As required in individual Specification Sections, prepare a written summary indicating types of products required for the Work and their intended location. Include the following information in tabular form:
 - 1) Type of product. Include unique identifier for each product indicated in the Contract Documents or assigned by Contractor if none is indicated.
 - 2) Manufacturer and product name, and model number if applicable.
 - 3) Number and name of room or space.
 - 4) Location within room or space.
- f. Design Data: Prepare and submit written and graphic information indicating compliance with indicated performance and design criteria in individual Specification Sections. Include list of assumptions and summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Number each page of submittal.
- g. Certificates:
 - 1) Certificates and Certifications Submittals: Submit a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity. Provide a notarized signature where indicated.
 - 2) Installer Certificates: Submit written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.
 - 3) Manufacturer Certificates: Submit written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.
 - 4) Material Certificates: Submit written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.
 - 5) Product Certificates: Submit written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.
 - 6) Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification and Procedure Qualification Record on AWS forms. Include names of firms and personnel certified.
- h. Test and Research Reports:
 - 1) Compatibility Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.
 - 2) Field Test Reports: Submit written reports indicating and interpreting results of field tests performed either during installation of product or after product is

installed in its final location, for compliance with requirements in the Contract Documents.

- 3) Material Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.
 - 4) Preconstruction Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.
 - i. Product Test Reports: Submit written reports indicating that current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.
 - 1) Research Reports: Submit written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project. Include the following information:
 - (a) Name of evaluation organization.
 - (b) Date of evaluation.
 - (c) Time period when report is in effect.
 - (d) Product and manufacturers' names.
 - (e) Description of product.
 - (f) Test procedures and results.
 - (g) Limitations of use
- C. Delegated Design Services
1. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
 - a. If criteria indicated are insufficient to perform services or certification required, submit a written request for additional information to Engineer.
 2. Delegated-Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit digitally signed PDF file and three paper copies of certificate, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.
 - a. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services
- D. Contractor's Review
1. Action Submittals and Informational Submittals: Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Engineer and Construction Manager.
 2. Contractor's Approval: Indicate Contractor's approval for each submittal with indication in web-based Project software. Include name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.
 - a. Engineer and Construction Manager will not review submittals received from Contractor that do not have Contractor's review and approval.
- E. Engineer's Review

1. Action Submittals: Engineer and Construction Manager will review each submittal, indicate corrections or revisions required and return it
 - a. PDF Submittals: Engineer and Construction Manager will indicate, via markup on each submittal, the appropriate action.
 2. Submittals by Web-Based Project Software: Engineer and Construction Manager will indicate, on Project software website, the appropriate action.
 3. Informational Submittals: Engineer and Construction Manager will review each submittal and will not return it or will return it if it does not comply with requirements. Engineer and Construction Manager will forward each submittal to appropriate party.
 4. Partial submittals prepared for a portion of the Work will be reviewed when use of partial submittals has received prior approval from Engineer and Construction Manager.
 5. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review.
 6. Engineer and Construction Manager will discard submittals received from sources other than Contractor.
 7. Submittals not required by the Contract Documents will be returned by Engineer without action.
 8. Except for demonstrating compliance with Sustainable Design and Construction requirements, MSDS are not required and will not be reviewed. Submittals received that contain MSDS will be returned by Engineer without action.
 9. A maximum of two re-submittals shall be reviewed by the Engineer. The Owner shall be entitled to deduct from the Contractors Contract Sum, amounts paid to Engineer to review more than the noted quantity of resubmittals.
 10. Materials or equipment that are procured, and work that is executed, without completing Action Submittal review shall be at the Contractor's risk.
 11. Review will be for general conformance only and shall not relieve the Contractor for any deviations from the requirements of the documents.
 - a. Exceptions: Fire protection and EMCS submittals can be provided separately. At the discretion of the {GT#10000044}, partial submittals may be provided. If allowed, provide a table indicating submittal status with each submittal, and provide an initial submittal with all required tabs and space for all current and future submittals.
 12. Efficiency Standards
 - a. Units requiring more than a 5% increase in power input beyond the scheduled equipment to meet design capacities will not be considered equal.
 - b. Units requiring more than a 15% increase in fan brake horsepower over the scheduled equipment to meet the design flow and external static pressure requirements will not be considered equal and will not be accepted.
- F. Substitution Procedures
1. Substitution Requests: Submit three copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
 2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
 - a. Statement indicating why specified product or fabrication or installation method cannot be provided, if applicable.
 - b. Coordination of information, including a list of changes or revisions needed to other parts of the Work and to construction performed by Owner and separate contractors that will be necessary to accommodate proposed substitution.
 - c. Detailed comparison of significant qualities of proposed substitutions with those of the Work specified. Include annotated copy of applicable Specification Section. Significant qualities may include attributes, such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific

- features and requirements indicated. Indicate deviations, if any, from the Work specified.
- d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
 - e. Samples, where applicable or requested.
 - f. Certificates and qualification data, where applicable or requested.
3. List of similar installations for completed projects, with project names and addresses as well as names and addresses of architects, engineers and owners.
- a. Material test reports from a qualified testing agency, indicating and interpreting test results for compliance with requirements indicated.
 - b. Research reports evidencing compliance with building code in effect for Project.
 - c. Detailed comparison of Contractor's construction schedule using proposed substitutions with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.
 - d. Cost information, including a proposal of change, if any, in the Contract Sum.
 - e. Contractor's certification that proposed substitution complies with requirements in the Contract Documents, except as indicated in substitution request, is compatible with related materials and is appropriate for applications indicated.
 - f. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.
4. Engineer's Action: If necessary, Engineer will request additional information or documentation for evaluation within seven days of receipt of a request for substitution. Engineer will notify Contractor through Construction Manager of acceptance or rejection of proposed substitution within 15 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.
- a. Forms of Acceptance: Change Order, Construction Change Directive, or Engineer's Supplemental Instructions for minor changes in the Work.
 - b. Use product specified if Engineer does not issue a decision on use of a proposed substitution within time allocated.
5. Quality Assurance
- a. Compatibility of Substitutions: Investigate and document compatibility of proposed substitution with related products and materials. Engage a qualified testing agency to perform compatibility tests recommended by manufacturers.
6. Procedures
- a. Coordination: Revise or adjust affected work as necessary to integrate work of the approved substitutions.
7. Substit
- a. Contractor's Responsibilities: By making requests for substitution, the Contractor:
 - 1) Represents that the Contractor has personally investigated the proposed substitute product and determined that it is equal or superior in all respects to that specified.
 - 2) Certifies that the cost data submitted is complete and includes all related costs under this Contract except the Engineer's evaluation and redesign costs, and waives all claims for additional costs related to the substitution which subsequently become apparent.
 - 3) Will submit for Engineer's evaluation all product data and samples deemed necessary by the Engineer. Such submission does not relieve Contractor for submission of specified product submittals and shop drawings.

- 4) Contractor initiated proposals: The Owner shall be entitled to deduct from the Contract Sum amounts paid to the Engineer to evaluate Contractor's proposed substitutions and to make agreed-upon changes in the Drawings and Specifications made necessary by the Owner's acceptance of such substitutions.
- b. Substitutions for Cause: Submit requests for substitution immediately on discovery of need for change, but not later than [15] days prior to time required for preparation and review of related submittals.
 - 1) Conditions: Engineer will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Engineer will return requests without action, except to record noncompliance with these requirements:
 - (a) Requested substitution is for a specified product that is no longer available, and offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner may have to assume. Owner's additional responsibilities may include compensation to Engineer for redesign and evaluation services, increased cost of other construction, and similar considerations.
 - (b) Requested substitution does not require extensive revisions to the Contract Documents.
 - (c) Requested substitution is consistent with the Contract Documents and will produce indicated results.
 - (d) Substitution request is fully documented and properly submitted.
 - (e) Requested substitution will not adversely affect Contractor's construction schedule.
 - (f) Requested substitution has received necessary approvals of authorities having jurisdiction.
 - (g) Requested substitution is compatible with other portions of the Work.
 - (h) Requested substitution has been coordinated with other portions of the Work.
 - (i) Requested substitution provides specified warranty.
 - (j) If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.
- c. Substitutions for Convenience: Engineer will consider requests for substitution if received within 60 days after the Notice to Proceed. Requests received after that time may be considered or rejected at discretion of Engineer.
 - 1) Conditions: Engineer will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Engineer will return requests without action, except to record noncompliance with these requirements:
 - (a) Requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's additional responsibilities may include compensation to Engineer for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.
 - (b) Requested substitution does not require extensive revisions to the Contract Documents.
 - (c) Requested substitution is consistent with the Contract Documents and will produce indicated results.

- (d) Substitution request is fully documented and properly submitted.
- (e) Requested substitution will not adversely affect Contractor's construction schedule.
- (f) Requested substitution has received necessary approvals of authorities having jurisdiction.
- (g) Requested substitution is compatible with other portions of the Work.
- (h) Requested substitution has been coordinated with other portions of the Work.
- (i) Requested substitution provides specified warranty.
- (j) If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

G. Alternates

- 1. Procedures
 - a. Coordination: Revise or adjust affected adjacent work as necessary to completely integrate work of the alternate into Project.
 - 1) Include as part of each alternate, miscellaneous devices, accessory objects, and similar items incidental to or required for a complete installation whether or not indicated as part of alternate.
- 2. Execute accepted alternates under the same conditions as other work of the Contract.
- 3. Schedule: A schedule of alternates is included at the end of this Section. Specification Sections referenced in schedule contain requirements for materials necessary to achieve the work described under each alternate.

1.09 WARRANTIES

A. General Warranty Requirements

- 1. The warranty period shall begin at the date of Substantial Completion.
- 2. If temporary use of equipment and/or systems is allowed prior to substantial completion, that shall not initiate the warranty period unless specifically noted otherwise. The warranty period shall be extended for equipment and systems as required to comply with the project warranty requirements.
- 3. Provide software and firmware updates for all equipment and systems that become available during the warranty period.
- 4. Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

B. Special Warranty Requirements

- 1. Warranty requirements included in individual specification sections are supplemental to the general warranty requirements for the project. All requirements are intended to be additive, and in no way to lessen general project warranty requirements. If general project warranty requirements are more stringent than requirements listed in an individual section, the more stringent requirement shall take precedence.
- 2. Documentation shall be provided for required additional warranties, and included in Operation and Maintenance Materials.

1.10 QUALITY ASSURANCE

A. Delegated Design Services

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

C. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Engineer.

D. Conflicting Requirements

1. Conflicting Standards and Other Requirements: If compliance with two or more standards or requirements are specified and the standards or requirements establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer conflicting requirements that are different, but apparently equal, to Engineer for direction before proceeding.
2. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Engineer for a decision before proceeding.

E. Action Submittals

1. Shop Drawings: For [integrated exterior] [laboratory] mockups.
2. Include plans, sections, and elevations, indicating materials and size of mockup construction.
 - a. Indicate manufacturer and model number of individual components.
 - b. Provide axonometric drawings for conditions difficult to illustrate in two dimensions.
3. Delegated-Design Services Submittal: In addition to Shop Drawings, Product Data, and other required submittals, submit a statement signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional, indicating that the products and systems are in compliance with performance and design criteria indicated. Include list of codes, loads, and other factors used in performing these services.

F. Informational Submittals:

1. Contractor's Quality-Control Plan: For quality-assurance and quality-control activities and responsibilities.
2. Qualification Data: For Contractor's quality-control personnel.
3. Contractor's Statement of Responsibility: When required by authorities having jurisdiction, submit copy of written statement of responsibility submitted to authorities having jurisdiction before starting work on the following systems:
 - a. Seismic-force-resisting system, designated seismic system, or component listed in the Statement of Special Inspections.
 - b. Main wind-force-resisting system or a wind-resisting component listed in the Statement of Special Inspections.
4. Testing Agency Qualifications: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.
5. Schedule of Tests and Inspections: Prepare in tabular form and include the following:
 - a. Specification Section number and title.
 - b. Entity responsible for performing tests and inspections.
 - c. Description of test and inspection.
 - d. Identification of applicable standards.
 - e. Identification of test and inspection methods.
 - f. Number of tests and inspections required.
 - g. Time schedule or time span for tests and inspections.
6. Requirements for obtaining samples.
 - a. Unique characteristics of each quality-control service.
7. Reports: Prepare and submit certified written reports and documents as specified.
8. Permits, Licenses, and Certificates: For Owner's record, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices,

receipts for fee payments, judgments, correspondence, records, and similar documents established for compliance with standards and regulations bearing on performance of the Work.

G. Contractor's Quality Control Plan

1. Quality-Control Plan, General: Submit quality-control plan within 10 Notice to Proceed, and not less than five days prior to preconstruction conference. Submit in format acceptable to Engineer. Identify personnel, procedures, controls, instructions, tests, records, and forms to be used to carry out Contractor's quality-assurance and quality-control responsibilities. Coordinate with Contractor's Construction Schedule.
2. Quality-Control Personnel Qualifications: Engage qualified personnel trained and experienced in managing and executing quality-assurance and quality-control procedures similar in nature and extent to those required for Project.
3. Submittal Procedure: Describe procedures for ensuring compliance with requirements through review and management of submittal process. Indicate qualifications of personnel responsible for submittal review.
4. Testing and Inspection: In quality-control plan, include a comprehensive schedule of Work requiring testing or inspection, including the following:
 - a. Contractor-performed tests and inspections including Subcontractor-performed tests and inspections. Include required tests and inspections and Contractor-elected tests and inspections. Distinguish source quality-control tests and inspections from field quality-control tests and inspections.
 - b. Special inspections required by authorities having jurisdiction and indicated on the Statement of Special Inspections.
 - c. Owner-performed tests and inspections indicated in the Contract Documents, including tests and inspections indicated to be performed by Commissioning Authority.
5. Continuous Inspection of Workmanship: Describe process for continuous inspection during construction to identify and correct deficiencies in workmanship in addition to testing and inspection specified. Indicate types of corrective actions to be required to bring work into compliance with standards of workmanship established by Contract requirements and approved mockups.
6. Monitoring and Documentation: Maintain testing and inspection reports including log of approved and rejected results. Include work Engineer has indicated as nonconforming or defective. Indicate corrective actions taken to bring nonconforming work into compliance with requirements. Comply with requirements of authorities having jurisdiction.

H. Reports and Documents

1. Test and Inspection Reports: Prepare and submit certified written reports specified in other Sections. Include the following:
 - a. Date of issue.
 - b. Project title and number.
 - c. Name, address, telephone number, and email address of testing agency.
 - d. Dates and locations of samples and tests or inspections.
 - e. Names of individuals making tests and inspections.
 - f. Description of the Work and test and inspection method.
 - g. Identification of product and Specification Section.
 - h. Complete test or inspection data.
 - i. Test and inspection results and an interpretation of test results.
 - j. Record of temperature and weather conditions at time of sample taking and testing and inspection.
 - k. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
 - l. Name and signature of laboratory inspector.

- m. Recommendations on retesting and reinspecting.
- 2. Manufacturer's Technical Representative's Field Reports: Prepare written information documenting manufacturer's technical representative's tests and inspections specified in other Sections. Include the following:
 - a. Name, address, telephone number, and email address of technical representative making report.
 - b. Statement on condition of substrates and their acceptability for installation of product.
 - c. Statement that products at Project site comply with requirements.
 - d. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
 - e. Results of operational and other tests and a statement of whether observed performance complies with requirements.
 - f. Statement whether conditions, products, and installation will affect warranty.
 - g. Other required items indicated in individual Specification Sections.
- 3. Factory-Authorized Service Representative's Reports: Prepare written information documenting manufacturer's factory-authorized service representative's tests and inspections specified in other Sections. Include the following:
 - a. Name, address, telephone number, and email address of factory-authorized service representative making report.
 - b. Statement that equipment complies with requirements.
 - c. Results of operational and other tests and a statement of whether observed performance complies with requirements.
 - d. Statement whether conditions, products, and installation will affect warranty.
 - e. Other required items indicated in individual Specification Sections.
- I. Quality Assurance
 - 1. General: Qualifications paragraphs in this article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.
 - 2. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units. As applicable, procure products from manufacturers able to meet qualification requirements, warranty requirements, and technical or factory-authorized service representative requirements.
 - 3. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
 - 4. Installer Qualifications: A firm or individual experienced in installing, erecting, applying, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.
 - 5. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that are similar in material, design, and extent to those indicated for this Project.
 - 6. Specialists: Certain Specification Sections require that specific construction activities shall be performed by entities who are recognized experts in those operations. Specialists shall satisfy qualification requirements indicated and shall be engaged for the activities indicated.
 - a. Requirements of authorities having jurisdiction shall supersede requirements for specialists.
 - 7. Testing Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspection indicated, as documented

- according to ASTM E 329; and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities.
8. Manufacturer's Technical Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
 9. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
 10. Preconstruction Testing: Where testing agency is indicated to perform preconstruction testing for compliance with specified requirements for performance and test methods, comply with the following:
 - a. Contractor responsibilities include the following:
 - 1) Provide test specimens representative of proposed products and construction.
 - 2) Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
 - 3) Provide sizes and configurations of test assemblies, mockups, and laboratory mockups to adequately demonstrate capability of products to comply with performance requirements.
 - 4) Build site-assembled test assemblies and mockups using installers who will perform same tasks for Project.
 - 5) Build laboratory mockups at testing facility using personnel, products, and methods of construction indicated for the completed Work.
 - 6) When testing is complete, remove test specimens and test assemblies; do not reuse products on Project.
 - b. Testing Agency Responsibilities: Submit a certified written report of each test, inspection, and similar quality-assurance service to Engineer and Commissioning Authority, with copy to Contractor. Interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from the Contract Documents.
 11. Mockups: Before installing portions of the Work requiring mockups, build mockups for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work:
 12. Build mockups of size indicated.
 - a. Build mockups in location indicated or, if not indicated, as directed by Architect.
 - b. Notify Engineer seven days in advance of dates and times when mockups will be constructed.
 - c. Employ supervisory personnel who will oversee mockup construction. Employ workers that will be employed to perform same tasks during the construction at Project.
 - d. Demonstrate the proposed range of aesthetic effects and workmanship.
 13. Obtain Engineer's approval of mockups before starting corresponding work, fabrication, or construction.
 - 1) Allow seven days for initial review and each re-review of each mockup.
 - b. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 - c. Demolish and remove mockups when directed unless otherwise indicated.
 14. Integrated Exterior Mockups: Construct integrated exterior mockup according to approved Shop Drawings. Coordinate installation of exterior envelope materials and products for which mockups are required in individual Specification Sections, along with supporting materials. Comply with requirements in "Mockups" Paragraph.

15. Room Mockups: Construct room mockups according to approved Shop Drawings incorporating required materials and assemblies, finished according to requirements. Provide required lighting and additional lighting where required to enable Engineer to evaluate quality of the Work. Comply with requirements in "Mockups" Paragraph.
 - a. Notify the Engineer of all material believed to be inadequate, unsuitable, in violation of law, ordinances, rules or regulations of authorities having jurisdiction.
- J. Quality Control
 1. Owner Responsibilities: Where quality-control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform these services.
 - a. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspection they are engaged to perform.
 - b. Payment for these services will be made from testing and inspection allowances, as authorized by Change Orders.
 - c. Costs for retesting and reinspecting construction that replaces or is necessitated by work that failed to comply with the Contract Documents will be charged to Contractor, and the Contract Sum will be adjusted by Change Order.
 2. Contractor Responsibilities: Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Perform additional quality-control activities, whether specified or not, to verify and document that the Work complies with requirements.
 - a. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.
 - b. Engage a qualified testing agency to perform quality-control services.
 - 1) Contractor shall not employ same entity engaged by Owner, unless agreed to in writing by Owner.
 - c. Notify testing agencies at least [24] hours in advance of time when Work that requires testing or inspection will be performed.
 - d. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
 - e. Testing and inspection requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
 - f. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.
 3. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.
 4. Testing Agency Responsibilities: Cooperate with Engineer, Commissioning Authority and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.
 - a. Notify Engineer, Commissioning Authority, and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
 - b. Determine the locations from which test samples will be taken and in which in-situ tests are conducted.
 - c. Conduct and interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.
 - d. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
 - e. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
 - f. Do not perform duties of Contractor.

5. Manufacturer's Technical Services: Where indicated, engage a manufacturer's technical representative to observe and inspect the Work. Manufacturer's technical representative's services include participation in preinstallation conferences, examination of substrates and conditions, verification of materials, observation of Installer activities, inspection of completed portions of the Work, and submittal of written reports.
 6. Associated Contractor Services: Cooperate with agencies and representatives performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:
 - a. Access to the Work.
 - b. Incidental labor and facilities necessary to facilitate tests and inspections.
 - c. Adequate quantities of representative samples of materials that require testing and inspection. Assist agency in obtaining samples.
 - d. Facilities for storage and field curing of test samples.
 - e. Delivery of samples to testing agencies.
 - f. Preliminary design mix proposed for use for material mixes that require control by testing agency.
 - g. Security and protection for samples and for testing and inspection equipment at Project site.
- K. Special Tests and Inspections
1. Special Tests and Inspections: Engage a qualified testing agency to conduct special tests and inspections required by authorities having jurisdiction as the responsibility of Owner, and as follows:
 - a. Verifying that manufacturer maintains detailed fabrication and quality-control procedures and reviewing the completeness and adequacy of those procedures to perform the Work.
 - b. Notifying Engineer, Commissioning Authority, and Contractor promptly of irregularities and deficiencies observed in the Work during performance of its services.
 - c. Submitting a certified written report of each test, inspection, and similar quality-control service to Engineer and Commissioning Authority with copy to Contractor and to authorities having jurisdiction.
 - d. Submitting a final report of special tests and inspections at Substantial Completion, which includes a list of unresolved deficiencies.
 - e. Interpreting tests and inspections and stating in each report whether tested and inspected work complies with or deviates from the Contract Documents.
 - f. Retesting and reinspecting corrected work.

1.11 TEMPORARY FACILITIES AND CONTROLS

- A. Use Charges
1. General: Installation and removal of and use charges for temporary facilities shall be included in the Contract Sum unless otherwise indicated. Allow other entities engaged in the Project to use temporary services and facilities without cost, including, but not limited to, [Owner's construction forces,] Engineer, [occupants of Project,] testing agencies, and authorities having jurisdiction.
 2. Sewer Service: [Pay] [Owner will pay] sewer-service use charges for sewer usage by all entities for construction operations.
 3. Water Service: [Pay] [Owner will pay] water-service use charges for water used by all entities for construction operations.
 4. Electric Power Service: [Pay] [Owner will pay] electric-power-service use charges for electricity used by all entities for construction operations.

5. Water and Sewer Service from Existing System: Water from Owner's existing water system is available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations.
 6. Electric Power Service from Existing System: Electric power from Owner's existing system is available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations.
- B. Informational Submittals
1. Site Utilization Plan: Show temporary facilities, temporary utility lines and connections, staging areas, construction site entrances, vehicle circulation, and parking areas for construction personnel.
 2. Implementation and Termination Schedule: Within 15 days of date established for commencement of the Work, submit schedule indicating implementation and termination dates of each temporary utility.
 3. Project Identification and Temporary Signs: Show fabrication and installation details, including plans, elevations, details, layouts, typestyles, graphic elements, and message content.
 4. Fire-Safety Program: Show compliance with requirements of NFPA 241 and authorities having jurisdiction. Indicate Contractor personnel responsible for management of fire-prevention program.
 5. Moisture- and Mold-Protection Plan: Describe procedures and controls for protecting materials and construction from water absorption and damage and mold.
 6. Dust- and HVAC-Control Plan: Submit coordination drawing and narrative that indicates the dust- and HVAC-control measures proposed for use, proposed locations, and proposed time frame for their operation. Include the following:
 - a. Locations of dust-control partitions at each phase of work.
 - b. HVAC system isolation schematic drawing.
 - c. Location of proposed air-filtration system discharge.
 - d. Waste-handling procedures.
 - e. Other dust-control measures.
- C. Quality Assurance
1. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.
 2. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.
 3. Accessible Temporary Egress: Comply with applicable provisions in [the United States Access Board's ADA-ABA Accessibility Guidelines] [and] [ICC/ANSI A117.1].
- D. Project Conditions
1. Temporary Use of Permanent Facilities: Engage Installer of each permanent service to assume responsibility for operation, maintenance, and protection of each permanent service during its use as a construction facility before Owner's acceptance, regardless of previously assigned responsibilities.

1.12 DELIVERY, STORAGE AND HANDLING

- A. Follow individual product specifications if directions supersede this section.
- B. Follow manufacturer's directions in delivery, storage, protection, and installation of equipment and materials.
- C. Promptly notify Owner's Representative in writing of conflicts between requirements of Contract Documents and Manufacturer's directions and obtain written instructions from Owner's Representative before proceeding with work. The Contractor shall bear expenses arising from correcting deficiencies of work that do not comply with manufacturer's directions or such written instructions from Owner's Representative.

- D. Handle, store, and protect equipment and materials to prevent damage before and during installation in accordance with the manufacturer's recommendations, and as approved by the Contracting Officer. Replace damaged or defective items.
- E. Store ductwork in a clean, dry location. If the location of storage cannot be protected from moisture, keep ductwork above grade level to protect from standing water.

1.13 PERMITS AND FEES

- A. All permits and inspections required to complete the Division 20, 21, 22 23 scope of work shall be included in the prices of the respective divisions' bid prices. All certifications provided as part of the permit and inspection process shall be provided to the Owner as part of the Mechanical scope of work as specified in these documents.
- B. All fees required by utility providers shall be included in the 20, 21, 22, 23 bid price, including water, gas, sanitary sewer, and storm sewer connections. This shall include all charges to the project by these agencies, including but not limited to general fees, equipment charges (meters, vaults, etc.), tap fees, and utility main installation charges.

1.14 PAYMENT REQUESTS

- A. Provide a breakdown of construction costs within 30 days of Notice to Proceed, with separate costs for each of the items listed in the table at the end of this section.
- B. Schedule of Value
 - 1. Coordination: Coordinate preparation of the schedule of values with preparation of Contractor's construction schedule.
 - a. Coordinate line items in the schedule of values with items required to be indicated as separate activities in Contractor's construction schedule.
 - b. Subschedules for separate elements / Phased Work: Where the Work is separated into phases requiring separately phased payments, provide subschedules showing values coordinated with each phase of payment.
 - 2. Provide a breakdown of the Contract Sum in enough detail to facilitate continued evaluation of Applications for Payment and progress reports. Provide multiple line items for principal subcontract amounts in excess of five percent of the Contract Sum.
 - 3. Allowances: Provide a separate line item in the schedule of values for each allowance. Show line-item value of unit-cost allowances, as a product of the unit cost, multiplied by measured quantity. Use information indicated in the Contract Documents to determine quantities.
 - 4. Overhead Costs: Include total cost and proportionate share of general overhead and profit for each line item.
- C. Applications for Payment
 - 1. Each Application for Payment following the initial Application for Payment shall be consistent with previous applications and payments as certified by Engineer and paid for by Owner.
 - 2. Stored Materials: Include in Application for Payment amounts applied for materials or equipment purchased or fabricated and stored, but not yet installed. Differentiate between items stored on-site and items stored off-site.
 - a. Provide certificate of insurance, evidence of transfer of title to Owner, and consent of surety to payment for stored materials.
 - b. Provide supporting documentation that verifies amount requested, such as paid invoices. Match amount requested with amounts indicated on documentation; do not include overhead and profit on stored materials.
 - c. Provide summary documentation for stored materials indicating the following:
 - 1) Value of materials previously stored and remaining stored as of date of previous Applications for Payment.

- 2) Value of previously stored materials put in place after date of previous Application for Payment and on or before date of current Application for Payment.
 - 3) Value of materials stored since date of previous Application for Payment and remaining stored as of date of current Application for Payment.
3. Transmittal: Submit three signed and notarized original copies of each Application for Payment to Engineer by a method ensuring receipt. One copy shall include waivers of lien and similar attachments if required.
 - a. Transmit each copy with a transmittal form listing attachments and recording appropriate information about application.
4. Waivers of Mechanic's Lien: With each Application for Payment, submit waivers of mechanic's lien from entities lawfully entitled to file a mechanic's lien arising out of the Contract and related to the Work covered by the payment subcontractors, sub-subcontractors, and suppliers for construction period covered by the previous application.
 - a. Submit partial waivers on each item for amount requested in previous application, after deduction for retainage, on each item.
 - b. When an application shows completion of an item, submit conditional final or full waivers.
 - c. Owner reserves the right to designate which entities involved in the Work must submit waivers.
 - d. Submit final Application for Payment with or preceded by conditional final waivers from every entity involved with performance of the Work covered by the application who is lawfully entitled to a lien.
 - e. Waiver Forms: Submit executed waivers of lien on forms acceptable to Owner.
5. Initial Application for Payment: Administrative actions and submittals that must precede or coincide with submittal of first Application for Payment include the following:
6. List of subcontractors.
 - a. Schedule of values.
 - b. Contractor's construction schedule (preliminary if not final).
 - c. Combined Contractor's construction schedule (preliminary if not final) incorporating Work of multiple contracts, with indication of acceptance of schedule by each Contractor.
 - d. Products list (preliminary if not final).
 - e. Sustainable design action plans, including preliminary project materials cost data.
 - f. Schedule of unit prices.
7. Submittal schedule (preliminary if not final).
 - a. List of Contractor's staff assignments.
 - b. List of Contractor's principal consultants.
 - c. Copies of building permits.
 - d. Copies of authorizations and licenses from authorities having jurisdiction for performance of the Work.
 - e. Initial progress report.
 - f. Report of preconstruction conference.
8. Application for Payment at Substantial Completion: After Engineer issues the Certificate of Substantial Completion, submit an Application for Payment showing 100 percent completion for portion of the Work claimed as substantially complete.
 - a. Include documentation supporting claim that the Work is substantially complete and a statement showing an accounting of changes to the Contract Sum.
 - b. This application shall reflect Certificate(s) of Substantial Completion issued previously for Owner occupancy of designated portions of the Work.
9. Final Payment Application: After completing Project closeout requirements, submit final Application for Payment with releases and supporting documentation not previously submitted and accepted, including, but not limited, to the following:

- a. Evidence of completion of Project closeout requirements.
 - b. Insurance certificates for products and completed operations where required and proof that taxes, fees, and similar obligations were paid.
 - c. Updated final statement, accounting for final changes to the Contract Sum.
 - d. AIA Document G706.
 - e. AIA Document G706A.
 - f. Evidence that claims have been settled.
 - g. Final meter readings for utilities, a measured record of stored fuel, and similar data as of date of Substantial Completion or when Owner took possession of and assumed responsibility for corresponding elements of the Work.
 - h. Final liquidated damages settlement statement
10. Submittals and operation and maintenance data must be received and approved before payment requests will be considered for materials and equipment.
 11. BMS submittals must be received before payment requests will be reviewed for this portion of the work. Only payment requests for programming and submittals will be reviewed until submittals are approved.
 12. Fire protection system submittals, including code-approved shop drawings, must be received before payment requests will be reviewed for this portion of the work. Only payment requests for design and submittals will be reviewed until submittals are approved.

1.15 VISITING THE PROJECT SITE

- A. The premises shall be examined and conditions shall be understood which may affect performance of work of this Division before submitting proposals for this work.
- B. No subsequent allowance for time or money will be considered for any consequence related to failure to examine existing site conditions.

PART 2 PRODUCTS

2.01 PRODUCTS FOR TEMPORARY FACILITIES AND CONTROLS

- A. Materials
 1. Chain-Link Fencing: Minimum 2-inch, 0.148-inch- thick, galvanized-steel, chain-link fabric fencing; minimum 6 feet high with galvanized-steel pipe posts; minimum 2-3/8-inch- OD line posts and 2-7/8-inch- OD corner and pull posts, with 1-5/8-inch- OD top rails.
 2. Portable Chain-Link Fencing: Minimum 2-inch, 0.148-inch- thick, galvanized-steel, chain-link fabric fencing; minimum 6 feet high with galvanized-steel pipe posts; minimum 2-3/8-inch- OD line posts and 2-7/8-inch- OD corner and pull posts, with 1-5/8-inch- OD top and bottom rails. Provide concrete bases for supporting posts.
 3. Fencing Windscreen Privacy Screen: Polyester fabric scrim with grommets for attachment to chain link fence, sized to height of fence, in color selected by Engineer from manufacturer's standard colors.
 4. Wood Enclosure Fence: Plywood, 8 feet high, framed with four 2-by-4-inch rails, with preservative-treated wood posts spaced not more than 8 feet apart.
 5. Polyethylene Sheet: Reinforced, fire-resistive sheet, 10-mil minimum thickness, with flame-spread rating of 15 or less per ASTM E 84 and passing NFPA 701 Test Method 2.
 6. Dust-Control Adhesive-Surface Walk-Off Mats: Provide mats minimum 36 by 60 inches.
 7. Insulation: Unfaced mineral-fiber blanket, manufactured from glass, slag wool, or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively.
- B. Temporary Facilities
 1. Common-Use Field Office: Of sufficient size to accommodate needs of Owner, Engineer, and construction personnel office activities and to accommodate Project meetings specified in other Division 01 Sections. Keep office clean and orderly. Furnish and equip offices as follows:

- a. Furniture required for Project-site documents including file cabinets, plan tables, plan racks, and bookcases.
- b. Conference room of sufficient size to accommodate meetings of [10] individuals. Provide electrical power service and 120-V ac duplex receptacles, with no fewer than one receptacle on each wall. Furnish room with conference table, chairs, and 4-foot-square tack and marker boards.
- c. Drinking water and private toilet.
- d. Heating and cooling equipment necessary to maintain a uniform indoor temperature of 68 to 72 deg F.
- e. Lighting fixtures capable of maintaining average illumination of 20 fc at desk height.
2. Storage and Fabrication Sheds: Provide sheds sized, furnished, and equipped to accommodate materials and equipment for construction operations.
 - a. Store combustible materials apart from building.

2.02 START UP SERVICE

- A. Refer to individual sections of these specifications for specific requirements.
- B. Start-up shall be performed by a certified representative when required. Prior to start-up, certification of representative shall be forwarded to the Engineer for review.
- C. Schedule start-up with the Owner. Perform operation and maintenance training at the time of start-up for equipment requiring start up service.

2.03 FIELD TESTING

- A. Test and Inspection Log
 1. Test and Inspection Log: Prepare a record of tests and inspections. Include the following:
 2. Date test or inspection was conducted.
 3. Description of the Work tested or inspected.
 4. Date test or inspection results were transmitted to Engineer.
 5. Identification of testing agency or special inspector conducting test or inspection.
- B. Maintain log at Project site. Post changes and revisions as they occur. Provide access to test and inspection log for Engineer's, Commissioning Authority's, reference during normal working hours.
 1. Submit log at Project closeout as part of Project Record Documents.
- C. Repair and Protection
 1. General: On completion of testing, inspection, sample taking, and similar services, repair damaged construction and restore substrates and finishes.
 - a. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible. Comply with the Contract Document requirements for cutting and patching in Section 017300 "Execution."
 2. Protect construction exposed by or for quality-control service activities.
 3. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services

2.04 PAINTING

- A. Painting of mechanical systems, equipment, and components is specified in Division 09.
- B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

2.05 CLEANING

- A. Leave all equipment and systems in a clean and new condition at the completion of the project. Clean all piping and ductwork exposed in finished spaces. Remove all stickers from equipment

in finished spaces (plumbing fixtures, etc.). Repair all scratched and damaged equipment to new condition, to include touch-up painting.

2.06 MECHANICAL DEMOLITION

- A. Refer to Division 01 and Division 02 for general demolition requirements and procedures.
- B. Disconnect, demolish, and remove Fire Protection systems, HVAC systems, Plumbing systems, equipment, and components indicated to be removed.
 - 1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
 - 2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
 - 3. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
 - 4. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.
 - 5. Equipment to Be Removed: Disconnect and cap services and remove equipment.
 - 6. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
 - 7. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
- C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

2.07 WORK IN EXISTING BUILDINGS

- A. Access to the existing building will be provided by the owner as required and a project schedule will identify access requirements to occupied buildings. Work shall be completed by the Contractor without interruption once Work has begun to facilitate returning the areas of work back to the Owner as soon as possible.
- B. Provide adequate protection of all existing and newly installed Work. Contractor shall promptly repair any damage to new or existing Work at Contractor's expense.
- C. Contractor shall consult with the Owner on methods of performing Work so the Owner's operation is not disrupted more than absolutely necessary. The Owner shall designate when interruption of existing services may occur. Contractor shall leave all services in operation until such time.
- D. All items and equipment removed as part of the demolition process shall remain property of the owner unless possession rights are waived. Contractor shall meet with Owner prior to start of demolition to determine which items are to be salvaged. Contractor shall remove remaining items from the site

END OF SECTION

**SECTION 20 05 00
COMMON MECHANICAL WORK RESULTS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Expansion Fittings and Loops for Piping
 - 1. Performance Requirements
 - 2. Packed Expansion Joints
 - 3. Packless Expansion Joints
 - 4. Grooved-Joint Expansion Joints, Lead Free – Plumbing Piping Only
 - 5. Grooved-Joint Expansion Joints – HVAC Piping Only
 - 6. Alignment Guides and Anchors - HVAC and Plumbing Piping
 - 7. Expansion loops and flexible expansion loops
 - 8. Flexible pipe connector
- B. Sleeves and Sleeve Seals for HVAC and Plumbing Piping
 - 1. Sleeves without Waterstop
 - 2. Sleeves with Waterstop
 - 3. Stack-Sleeve Fittings
 - 4. Sleeve Seal Systems
 - 5. Firestop Systems
 - 6. Grout
 - 7. Silicone Sealants
- C. Escutcheons and Floor Plates for HVAC and Plumbing Piping
 - 1. Escutcheons
 - 2. Floor Plates

1.02 GENERAL REFERENCES

- A. Contract Documents: Refer to complete set of Contract Documents for requirements that are related to or may affect the work described in this Section.
- B. Division 20, including all Common Mechanical Requirements in Section 20 00 00, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.
 - 1. Escutcheons

1.03 RELATED REQUIREMENTS

- A. Division 22 Section "Domestic Water Piping Specialties" for water meters.
- B. Division 07 Section "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.
- C. Division 23 Section "Hydronic Piping"
- D. Division 23 Section "Hydronic Specialties"
- E. Division 23 Section "Refrigerant Piping"

1.04 REFERENCE STANDARDS

- A. ASME B18.10 - Track Bolts and Nuts; 2006.
- B. ASME B31.5 - Refrigeration Piping and Heat Transfer Components; 2022.
- C. ASME B31.9 - Building Services Piping; 2020.
- D. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2024.

- E. ASTM A183 - Standard Specification for Carbon Steel Track Bolts and Nuts; 2014 (Reapproved 2020).
- F. ASTM A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength; 2021.
- G. ASTM A312/A312M - Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes; 2022a.
- H. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; 2018.
- I. ASTM F844 - Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use; 2019 (Reaffirmed 2024).
- J. ASTM F1007 - Standard Specification for Packed Slip-Type Expansion Joints; Approved Edition.
- K. ASTM F1120 - Circular Metallic Bellows-Type Expansion Joints; 2019.
- L. ASTM F1123 - Non-Metallic Expansion Joints; 2019.
- M. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2025.
- N. AWWA C606 - Grooved and Shouldered Joints; 2022.
- O. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2018, with Amendment (2019).
- P. NSF 61 - Drinking Water System Components - Health Effects; 2024.
- Q. NSF 372 - Drinking Water System Components - Lead Content; 2024.
- R. UL 1479 - Standard for Fire Tests of Penetration Firestops; Current Edition, Including All Revisions.

1.05 DEFINITIONS

- A. Existing Piping to Remain: Existing piping that is not to be removed and that is not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled

1.06 PERFORMANCE REQUIREMENTS

- A. Domestic water expansion fittings and loops for plumbing piping intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act, with requirements of authorities having jurisdiction, and with NSF 61 and NSF 372, or be certified in compliance with NSF 61 and NSF 372 by an ANSI-accredited third-party certification body, in that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.
- B. Compatibility: Provide products suitable for piping service fluids, materials, working pressures, and temperatures.
- C. Capability: Provide products and installations to accommodate maximum axial movement as scheduled or indicated on Drawings.
- D. Capability: HVAC Products
 - 1. Refrigerant piping: Comply with ASME B31.5.
 - 2. Heating hot water 200°F maximum
- E. Capability: Products to absorb 200 percent of maximum axial movement between anchors

1.07 SUBMITTALS

- A. Action Submittals
 - 1. For each type of product
 - a. Include construction details, material descriptions, and dimensions of individual components, and finishes.
 - b. Include operating characteristics and furnished accessories

2. Delegated Design Submittals: For each anchor and alignment guide, including analysis data, signed and sealed by the qualified professional engineer responsible for their preparation.
 - a. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and swing connections.
 - b. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
 - c. Alignment Guide Details: Detail field assembly and attachment to building structure.
 - d. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.
3. Sustainable Design Submittals:
 - a. Product Data: For sealants, indicating VOC content.
 - b. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
 - c. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.
4. Required Embodied Carbon Submittals: All products which satisfy one of the following criteria will require an Embodied Carbon Submittal:
 - a. The product is a 'Major' piece of equipment
 - b. The product contains refrigerant
 - c. The cost of a group of products serving a given function constitutes 5% or greater of the sub-contractor's budget, excluding labor.
5. Embodied Carbon Submittals
 - a. Order of Preferred Submittals: For products which require an embodied carbon submittal (described above), one of the following must be provided. The submittal must be that with the highest preference available. The order preference, from highest to lowest is:
 - 1) Product Specific, Facility Specific EPD
 - 2) Product Specific EPD
 - 3) Industry Average EPD
 - 4) TM65 Manufacturer Form with Mid-Level Calculation data
 - 5) TM65 Manufacturer Form with Basic Calculation data
- B. Shop Drawings: Furnish shop drawings detailing seismic expansion and thermal anchors, support and guide locations, welding of structure and catalog data on expansion joints. Signed and sealed by a qualified professional engineer.
 1. Design Calculations: For thermal expansion of piping systems and selection and design of expansion fittings and loops.
 2. Anchor Details: Detail fabrication of each indicated. Show dimensions and methods of assembly.
 3. Alignment guide Details: Detail field assembly and anchorage.
- C. Informational Submittals
 1. Welding certificates.
 2. Field quality-control reports.
 3. Submittal:
 - a. Product Schedule: For each penetration firestopping system, include location and design designation of qualified testing and inspection agency.
 - b. Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping condition, submit illustration, with modifications marked, approved by penetration firestopping

- manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.
 - c. Submit a schedule with reference number for each flexible connector and expansion joint indicating all features and data for each connector cross referenced to supporting product data indicating manufacturer's number, size, location, and features for each expansion fitting and loop.
 - d. Submit as-built drawings indicating actual locations of flexible pipe connectors, expansion joints, anchors, and guides.
- D. Operation and Maintenance Materials
- 1. Operation and Maintenance Data: For each type of expansion joint, and gauge to include in operation and maintenance manuals.
 - a. Maintenance Data: indicate adjustment instructions.
 - b. Manufacturer's Installation Instruction: Indicate special procedures, and external controls.

1.08 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M.
- B. Pipe and Pressure-Vessel Welding Qualifications: Qualify procedures and operators in accordance with 2021 ASME Boiler and Pressure Vessel Code, Section IX.
- C. Regulatory Requirements: Comply with all applicable requirements of the laws, codes, and ordinances and regulations, authorities having jurisdiction. Obtain necessary approvals from all such authorities.
- D. Qualifications:
 - 1. Contractor: Contractor is responsible for quality of the Work.
 - 2. Manufacturer: A firm experienced in successfully producing work similar to that indicated for this Project with sufficient production capacity to produce required units without causing delay in the Work. Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
 - 3. An installer trained by the manufacturer in the use of the materials and equipment to be employed in the Work.
- E. Engineer Qualifications: Unless stated otherwise in other sections, provide the following:
 - 1. Structural Engineer legally licensed and qualified to practice in the State of Alaska and experienced in, and having a minimum of ten (10) consecutive years providing this type of engineering services.
 - 2. Engineering services are defined as those performed for the design, fabrication and installation of components and assemblies required to accommodate pipe expansion.
- F. Flexible expansion joints for potable water piping shall be UL classified in accordance with NSF 61.

1.09 COORDINATION

- A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for installations.
- B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- C. Coordinate requirements for access panels and doors for items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."
- D. Under provisions of commissioning documentation; testing of mechanical equipment, as well as training of owner's operation and maintenance personnel, shall be required in cooperation with the commissioning agent.

- E. Refer to the Owner/Utility tie-in schedule.
- F. Each contractor shall coordinate its construction operations with those of other contractors and entities to ensure efficient and orderly installation of each part of the Work.
- G. Each contractor shall coordinate its operations with operations, included in different sections, which depend on each other for proper installation, connection, and operation.
 - 1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
 - 2. Coordinate installation of different components with other contractors to ensure maximum accessibility for required maintenance, service, and repair.
 - 3. Make adequate provisions to accommodate items scheduled for later installation.
 - 4. Where availability of space is limited, coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair of all components, including mechanical and electrical.
- H. Contractor shall participate in whole building information modeling coordination process utilizing a three-dimensional software platform compatible with Autodesk® Navisworks®. Contractor shall include all time associated with detailing, coordination meetings, and model generation for the BIM coordination process.

1.10 DELIVERY, STORAGE AND HANDLING

- A. Delivery and Acceptance Requirements: Deliver materials in manufacturer's original packaging with label indicating pertinent information identifying the item.
 - 1. Pertinent Information: Manufacturer's labels identifying product and manufacturer, date of manufacture, lot number, shelf life if applicable, qualified testing and inspecting agency's classification marking applicable to Project; curing time, and mixing instructions for multicomponent materials.
- B. Storage and Handling Requirements: Store materials in accordance with manufacturer's instructions in a protected dry location off ground. Do not open packaging nor remove labels until time of installation.
- C. Store and handle firestopping materials to prevent their deterioration or damage due to moisture, temperature changes, contaminants, or other causes
- D. Deliver ductwork, pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent ductwork and pipe end damage and to prevent entrance of dirt, debris, and moisture.
- E. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.
- F. During installation, provide temporary caps of sufficient material to prevent entrance of dirt, debris, and moisture.

1.11 DELEGATED DESIGN OF EXPANSION FITTINGS AND LOOPS FOR PIPING

- A. Expansion fitting and loop Products in this section are to be included in a delegated design to be performed by installing contractor. Complete design including but not limited to products, locations, etc. are to be signed and sealed by the qualified professional engineer responsible for their preparation.
- B. Provide delegated design of piping expansion loops, anchors and guides conforming to this section, and to limitations specified on project structural design documents, including design, engineering, and performance of the system.
- C. Drawings of piping layouts are diagrammatic and are intended only to show:
 - 1. Design intent of finished materials, and approximate routing.
 - 2. Relationships between elements.
 - 3. Location, identification, and size of components, assemblies, equipment and accessories.
 - 4. Schematic attachment details and diagrams of fasteners and connections.

- D. Proposed delegated design solutions are to demonstrate compliance with the original design intent of the Contract Documents, as determined by the Architect. Proposed design solutions that exactly follow details indicated on the Drawings do not relieve Contractor of responsibility for design and performance of delegated design portions of the Work.
- E. Design to meet or exceed specified performance requirements, to satisfy the requirements of the authorities having jurisdiction, and to provide structurally sound assemblies capable of withstanding the specified in-service loads without failure.
- F. Fabricate, assemble and install to accommodate the full range of manufacturing, operating and field installation tolerances of adjacent work specified in other Sections.
- G. If required by the authorities having jurisdiction, submit shop drawings, specifications, calculations and other supporting data necessary for obtaining jurisdiction approval after they have been reviewed by the Architect and prior to beginning installation. Pay fees incurred.

PART 2 PRODUCTS

2.01 EXPANSION FITTINGS AND LOOPS FOR PIPING

- A. Performance Requirements:
 - 1. Compatibility: Provide products suitable for piping service fluids, materials, working pressures, and temperatures.
 - 2. Capability: Products to absorb 200 percent of maximum calculated axial movement between anchors.
 - 3. Pipe alignment guides shall be selected for both upward and downward motion.
- B. Packed Expansion Joints:
 - 1. Flexible, Ball-Joint, Packed Expansion Joints – HVAC Piping Only:
 - a. Manufacturers:
 - 1) Advanced Thermal Systems, Inc.
 - 2) Hyspan Precision Products, Inc.
 - b. Standards: ASME Boiler and Pressure Vessel Code: Section II, "Materials"; and ASME B31.9, "Building Services Piping," for materials and design of pressure-containing parts and bolting.
 - c. Material: Carbon-steel assembly with asbestos-free composition packing.
 - d. Design: For 360-degree rotation and angular deflection.
 - e. Minimum Pressure Rating: 250 psig at 400 deg F.
 - f. Angular Deflection for NPS 6 (DN 150) and Smaller: 30 degree minimum.
 - g. Angular Deflection for NPS 8 (DN 200) and Larger: 15 degree minimum.
 - h. End Connections for NPS 2 (DN 50) and Smaller: Threaded.
 - i. End Connections for NPS 2-1/2 (DN 65) and Larger: Flanged.
 - 2. Slip-Joint Packed Expansion Joints – HVAC Piping Only:
 - a. Manufacturers:
 - 1) Adsko Manufacturing LLC.
 - 2) Advanced Thermal Systems, Inc.
 - 3) Hyspan Precision Products, Inc.
 - b. Standard: ASTM F1007.
 - c. Material: Carbon steel with asbestos-free PTFE packing.
 - d. Design: With internal guide and injection device for repacking under pressure. Include drip connection if used for steam piping.
 - e. Configuration: Single joint with base class(es) unless otherwise indicated.
 - f. End Connections: Flanged or weld ends to match piping system
- C. Packless Expansion Joints:
 - 1. Metal, Expansion-Compensator Packless Expansion Joints - HVAC Piping Only:
 - a. Manufacturers:
 - 1) Adsko Manufacturing LLC.

- 2) Hyspan Precision Products, Inc.
 - 3) Metraflex, Inc.
 - b. Minimum Pressure Rating: 150 psig unless otherwise indicated.
 - c. Configuration for Copper Tubing: Two-ply, phosphor-bronze bellows with copper pipe ends.
 - d. End Connections for Copper Tubing NPS 2 (DN 50) and Smaller: Solder joint or threaded.
 - e. End Connections for Copper Tubing NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Threaded.
 - f. Configuration for Steel Piping: Two-ply, stainless-steel bellows; steel-pipe end connections; and carbon-steel shroud.
 - g. End Connections for Steel Pipe NPS 2 (DN 50) and Smaller: Threaded.
 - h. End Connections for Steel Pipe NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged.
- 2. Rubber Union Connector Expansion Joints, Lead Free – Plumbing Piping Only:
 - a. Manufacturers:
 - 1) Flex-Hose Co., Inc.
 - 2) Flexicraft Industries.
 - 3) General Rubber Corporation.
 - 4) Mason Industries, Inc.
 - 5) Metraflex Company (The).
 - b. Source Limitations: Obtain rubber union connector expansion joints from single manufacturer.
 - c. Material: Twin reinforced EPDM rubber spheres with external restraining cables.
 - d. Minimum Pressure Rating: 150 psig at 170 deg F unless otherwise indicated.
 - e. End Connections for NPS 2 (DN 50) and Smaller: Threaded.
 - f. End Connections for Greater than NPS 2 (DN 50): Flanged.
 - g. End Fittings: Stainless steel.
- 3. Flexible-Hose Packless Expansion Joints, Lead Free – Plumbing Piping Only:
 - a. Manufacturers:
 - 1) Flex-Hose Co., Inc.
 - 2) Flex-Pression.
 - 3) Flexicraft Industries.
 - 4) Mason Industries, Inc.
 - 5) Metraflex Company (The).
 - b. Source Limitations: Obtain flexible-hose packless expansion joints from single manufacturer.
 - c. Description: Manufactured assembly with inlet and outlet elbow fittings and two flexible-metal-hose legs joined by long-radius, 180-degree return bend or center section of flexible hose.
 - d. Flexible Hose: Corrugated-metal inner hoses and braided outer sheaths.
 - e. Expansion Joints for Copper Tubing NPS 2 (DN 50) and Smaller: Copper-alloy fittings with solder-joint end connections.
 - 1) Bronze hoses and double-braid bronze sheaths with 700 psig at 70 deg F and 500 psig at 450 deg F ratings.
 - f. Expansion Joints for Copper Tubing NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Copper-alloy fittings with threaded end connections.
 - 1) Stainless steel hoses and double-braid, stainless steel sheaths with 420 psig at 70 deg F and 315 psig at 450 deg F ratings.
 - g. Expansion Joints for Stainless Steel Piping NPS 2 (DN 50) and Smaller: Stainless steel fittings with threaded end connections.
 - 1) Stainless steel hoses and double-braid, stainless steel sheaths with 700 psig at 70 deg F and 515 psig at 600 deg F ratings.

- h. Expansion Joints for Stainless Steel Piping NPS 2-1/2 to NPS 6 (DN 65 to DN 150): Stainless steel fittings with flanged or welded end connections.
 - 1) Stainless steel hoses and double-braid, stainless steel sheaths with 275 psig at 70 deg F and 200 psig at 600 deg F ratings.
- i. Expansion Joints for Stainless Steel Piping NPS 8 to NPS 12 (DN 200 to DN 300): Stainless steel fittings with flanged or welded end connections.
 - 1) Stainless steel hoses and double-braid, stainless steel sheaths with 165 psig at 70 deg F and 120 psig at 600 deg F ratings.
- j. Expansion Joints for Stainless Steel Piping NPS 14 (DN 350) and Larger: Stainless steel fittings with flanged or welded end connections.
 - 1) Stainless steel hoses and double-braid, stainless steel sheaths with 165 psig at 70 deg F and 120 psig at 600 deg F ratings.
- k. Expansion Joints for Steel Piping NPS 2-1/2 to NPS 6 (DN 65 to DN 150): Carbon steel fittings with flanged or welded end connections.
 - 1) Stainless steel hoses and double-braid, stainless steel sheaths with 275 psig at 70 deg F and 200 psig at 600 deg F ratings.
- l. Expansion Joints for Steel Piping NPS 8 to NPS 12 (DN 200 to DN 300): Carbon steel fittings with flanged or welded end connections.
 - 1) Stainless steel hoses and double-braid, stainless steel sheaths with 165 psig at 70 deg F and 120 psig at 600 deg F ratings.
- m. Expansion Joints for Steel Piping NPS 14 (DN 350) and Larger: Carbon steel fittings with flanged or welded end connections.
 - 1) Stainless steel hoses and double-braid, stainless steel sheaths with 165 psig at 70 deg F and 120 psig at 600 deg F ratings.
- 4. Metal-Bellows Packless Expansion Joints – HVAC and Plumbing Piping:
 - a. Manufacturers:
 - 1) Flex-Hose Co., Inc.
 - 2) Flex-Pression.
 - 3) Flex-Weld; a division of Kelco.
 - 4) Flexicraft Industries.
 - 5) Mason Industries, Inc.
 - 6) Metraflex Company (The).
 - b. For Plumbing Piping: Comply with all lead-free requirements
 - c. Source Limitations: Obtain metal-bellows packless expansion joints from single manufacturer.
 - d. Standards: ASTM F1120 and EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."
 - e. Type: Circular, corrugated bellows with external tie rods.
 - f. Minimum Pressure Rating: 200 psig unless otherwise indicated.
 - g. Configuration: Single joint with base and double joint with base class(es) unless otherwise indicated.
 - h. Expansion Joints for Copper Tubing: multi-ply phosphor-bronze bellows, copper pipe ends, and brass shrouds.
 - 1) End Connections for Copper Tubing NPS 2 (DN 50) and Smaller: Solder joint or threaded.
 - 2) End Connections for Copper Tubing NPS 2-1/2 to NPS 4 (DN 65 to DN 100): threaded.
 - 3) End Connections for Copper Tubing NPS 5 (DN 125) and Larger: Flanged.
 - i. Expansion Joints for Stainless Steel Piping: multi-ply stainless steel bellows, stainless steel pipe ends, and carbon steel shroud.
 - 1) End Connections for Stainless Steel Pipe NPS 2 (DN 50) and Smaller: Threaded.

- 2) End Connections for Stainless Steel Pipe NPS 2-1/2 (DN 65) and Larger: Flanged Welded.
5. Externally Pressurized Metal-Bellows Packless Expansion Joints, Lead Free – Plumbing Piping Only:
 - a. Manufacturers:
 - 1) Flex-Hose Co., Inc.
 - 2) Flexicraft Industries.
 - 3) Mason Industries, Inc.
 - 4) Metraflex Company (The).
 - b. Source Limitations: Obtain externally pressurized metal-bellows packless expansion joints from single manufacturer.
 - c. Minimum Pressure Rating: 300 psig unless otherwise indicated.
 - d. Description:
 - 1) Totally enclosed, externally pressurized, multi-ply, stainless steel bellows isolated from fluid flow by an internal pipe sleeve.
 - 2) Carbon-steel housing.
 - 3) Drain plugs and lifting lug for NPS 3 (DN 75) and larger.
 - 4) Bellows: With operating clearance between the internal pipe sleeves and external shrouds.
 - 5) Joints: Supplied with a built-in scale to confirm the starting position and operating movement.
 - 6) Joint Axial Movement: 4 inches of compression and 1 inch of extension.
 - e. Permanent Locking Bolts: Set locking bolts to maintain joint lengths during installation. Temporary welding tabs that are removed after installation in lieu of locking bolts are unacceptable.
 - f. End Connection Configuration: Flanged; one raised, fixed and one floating flange.
6. Rubber Packless Expansion Joints, Lead Free – Plumbing Piping Only:
 - a. Manufacturers:
 - 1) Flex-Hose Co., Inc.
 - 2) Flexicraft Industries.
 - 3) Mason Industries, Inc.
 - 4) Metraflex Company (The).
 - b. Source Limitations: Obtain rubber packless expansion joints from single manufacturer.
 - c. Standards: ASTM F1123 and FSA's "Expansion Joints - Piping Technical Handbook."
 - d. Material: Fabric-reinforced EPDM rubber complying with FSA-PSJ-703.
 - e. Spherical Type: Single or multiple spheres with external control rods.
 - f. Minimum Pressure Rating for NPS 1-1/2 to NPS 12 (DN 40 to DN 300): 225 psig at 170 deg F.
- D. Grooved-Joint Expansion Joints, Lead Free – Plumbing Piping Only
 1. Manufacturers:
 - a. Anvil International/Smith-Cooper International; Tailwind Capital, LLC
 - b. Shurjoint; a part of Aalberts Integrated piping Systems.
 - c. Victaulic Company.
 2. Source Limitations: Obtain grooved-joint expansion joints from single manufacturer.
 3. Description: Factory-assembled expansion joint made of several grooved-end pipe nipples, couplings, and grooved joints.
 4. Standard: AWWA C606, for grooved joints.
 5. Material: ASTM A53/A53M, Schedule 40 stainless steel pipe with grooved ends.
 6. Couplings: ASTM A312/A312M ductile-iron flexible type for stainless steel pipe dimensions. Include ferrous housing sections, Grade E EPDM rubber gasket or Grade P fluoroelastomer blend gasket, and bolts and nuts.

- E. Grooved-Joint Expansion Joints – HVAC Piping Only
 - 1. For use on hydronic piping only.
 - a. Manufacturers:
 - 1) Anvil International/Smith-Cooper International; Tailwind Capital, LLC
 - 2) Shurjoint; a part of Aalberts Integrated piping Systems.
 - 3) Victaulic Company.
 - 2. Source Limitations: Obtain grooved-joint expansion joints from single manufacturer
 - 3. Description: Factory-assembled expansion joint made of several grooved-end pipe nipples, couplings, and grooved joints.
 - 4. Standard: AWWA C606, for grooved joints.
 - 5. Nipples: ASTM A53/A53M, Schedule 40, Type E or S, steel pipe with grooved ends.
 - 6. Couplings: Five, flexible type for steel-pipe dimensions. Include ferrous housing sections, Buna-N gasket suitable for diluted acid, alkaline fluids, and cold and hot water, and bolts and nuts
- F. Alignment Guides and Anchors - HVAC and Plumbing Piping:
 - 1. Alignment Guides:
 - a. Manufacturers:
 - 1) Advanced Thermal Systems, Inc.
 - 2) Flex-Hose Co., Inc.
 - 3) Flexicraft Industries.
 - 4) Metraflex Company (The).
 - b. Source Limitations: Obtain alignment guides from single manufacturer.
 - c. Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding slider for bolting to pipe. Provide dielectric spacer for use with copper tubing/piping.
 - 2. Anchor Materials – HVAC and Plumbing Piping:
 - a. Steel Shapes and Plates: ASTM A36/A36M.
 - b. Bolts and Nuts: ASME B18.10 or ASTM A183, steel hex head.
 - c. Washers: ASTM F844, steel, plain, flat washers.
 - d. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, with tension and shear capacities appropriate for application.
 - 1) Stud: Threaded, stainless steel.
 - 2) Expansion Plug: Stainless steel.
 - 3) Washer and Nut: Stainless steel.
 - e. Chemical Fasteners: Insert-type stud, bonding-system anchor for use with hardened portland cement concrete, with tension and shear capacities appropriate for application.
 - 1) Bonding Material: ASTM C881/C881M, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
 - 2) Stud: ASTM A307, stainless steel with continuous thread on stud unless otherwise indicated.
 - 3) Washer and Nut: Stainless steel

2.02 SLEEVES AND SLEEVE SEALS FOR HVAC AND PLUMBING PIPING

- A. Sleeves without Waterstop:
 - 1. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron, with plain ends.
 - 2. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, hot-dip galvanized, with plain ends.
 - 3. Steel Sheet Sleeves: ASTM A653/A653M, 24 gauge minimum thickness; hot-dip galvanized, round tube closed with welded longitudinal joint

- B. Sleeves with Waterstop:
 - 1. Manufacturers:
 - a. Advance Products & Systems, LLC.
 - b. CALPICO, Inc.
 - c. Metraflex Company (The).
 - 2. Description: Manufactured PVC/HDPE, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall
- C. Stack-Sleeve Fittings:
 - 1. Manufacturers:
 - a. Jay R. Smith Mfg Co; a division of Morris Group International.
 - b. Wade; a subsidiary of McWane Inc.
 - c. Zurn Industries, LLC.
 - 2. Description: Manufactured, Dura-coated or Duco-coated cast-iron sleeve with integral clamping flange for use in waterproof floors and roofs. Include clamping ring, bolts, and nuts for membrane flashing.
 - 3. Underdeck Clamp: Clamping ring with setscrews
- D. Sleeve Seal Systems:
 - 1. Manufacturers:
 - a. Advance Products & Systems, LLC.
 - b. GPT; a division of EnPRO Industries.
 - c. Metraflex Company (The).
 - d. Proco Products, Inc.
 - 2. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
 - a. Hydrostatic Seal: 20 psig minimum.
 - b. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - c. Pressure Plates: Stainless steel.
 - d. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements
- E. Firestop Systems
 - 1. Manufacturers:
 - a. HoldRite HydroFlame, a Brand of Reliance Worldwide Corporation
 - b. 3M
 - c. Specified Technologies Inc. (STI)
 - 2. Design Criteria:
 - a. For the following constructions, provide through-penetration firestop systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance of assembly penetrated.
 - 1) Fire-resistance-rated walls, including partitions, with fire-protection-rated openings.
 - 2) Fire-resistance-rated floor and roof assemblies.
 - b. F-Rated Systems: Provide through-penetration firestop systems with F-ratings indicated, as determined by ASTM E814, but not less than that equaling, or exceeding fire-resistance rating of constructions penetrated.
 - c. T-Rated Systems: For the following conditions, provide through-penetration firestop systems with T-ratings, as determined by ASTM E814, where systems protect penetrating items exposed to potential contact with adjacent combustible materials in occupied floor areas:
 - 1) Penetrations located outside wall cavities.

- 2) Penetrations located outside fire-resistive shaft enclosures.
 - d. L-Rating: Per ASTM E814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.
 - e. W-Rating: Penetrations in horizontal assemblies, provide penetration firestopping showing no evidence of water leakage when tested to UL 1479.
3. Penetration Firestopping:
 - a. Provide penetration firestopping that is produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated.
4. Fill Material:
 - a. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors.
 - b. Latex Sealants: Single-component latex formulations that do not re-emulsify after cure during exposure to moisture.
 - c. Firestop Devices: Factory-assembled collars formed from galvanized and lined with intumescent material sized to fit specific diameter of penetrant.
 - d. Intumescent Wrap Strips: Single-component intumescent strips.
 - e. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants; pourable (self-leveling) formulation for openings in floors and other horizontal surfaces, and non-sag (caulk-grade) for openings in vertical and sloped surfaces
- F. Grout:
 1. Description: Nonshrink, for interior and exterior sealing openings in non-fire-rated walls or floors.
 2. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
 3. Design Mix: 5000 psi, 28-day compressive strength.
 4. Packaging: Premixed and factory packaged.
- G. Silicone Sealants
 1. Silicone Sealant, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant.
 - a. Manufacturers
 - 1) GE Construction Sealants; Momentive Performance Materials Inc.
 - 2) ITW Polymers Sealants North America.
 - 3) Polymeric Systems, Inc.
 - 4) Sherwin-Williams Company (The).
 - 5) Sika Corporation.
 - 6) The Dow Chemical Company.
 - 7) Tremco Incorporated.
 2. Standard: ASTM C920, Type S, Grade NS, Class 25, Use NT.
 3. Silicone Sealant, S, P, T, NT: Single-component, 25, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant.
 - a. Manufacturers:
 - 1) Pecora Corporation.
 - 2) Sika Corporation.
 - 3) The Dow Chemical Company.
 - 4) Tremco Incorporated.
 4. Standard: ASTM C920, Type S, Grade P, Class 25], Uses T and NT.
 5. Silicone Foam Sealant: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.
 - a. Manufacturers:

1) Smooth-On

2.03 ESCUTCHEONS AND FLOOR PLATES FOR HVAC AND PLUMBING PIPING

- A. Escutcheons:
 - 1. One-Piece, Steel Type: With polished, chrome-plated finish and setscrew fastener.
 - 2. One-Piece, Stainless Steel Type: With polished stainless steel finish.
 - 3. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.
 - 4. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished, chrome-plated finish and spring-clip fasteners.
 - 5. One-Piece, Stamped-Steel Type: With polished, chrome-plated finish and spring-clip fasteners.
 - 6. Split-Plate, Stamped-Steel Type: With polished, chrome-plated finish; concealed hinge; and spring-clip fasteners.
- B. Floor Plates
 - 1. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.
 - 2. Split-Casting Floor Plates: Cast brass with concealed hinge.

PART 3 EXECUTION

- A. Sleeves Application
 - 1. Use sleeves and sleeve seals for the following piping-penetration applications:
 - a. Exterior Concrete Walls above and below Grade:
 - 1) Sleeves with waterstops.
 - (a) Select sleeve size to allow for 1 inch (25 mm) annular clear space between piping and sleeve for installing sleeve-seal system.
 - b. Concrete Slabs-on-Grade:
 - 1) Sleeves with waterstops.
 - (a) Select sleeve size to allow for 1 inch (25 mm) 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.
 - c. Concrete Slabs above Grade:
 - 1) Sleeves with waterstops for all wet areas or stack-sleeve fittings for dry spaces. Coordinate with Architectural drawings and waterproofing requirements.
 - d. Interior Wall and Partitions:
 - 1) Sleeves without waterstops.
- B. Escutcheons Application
 - 1. Escutcheons for New Piping and Relocated Existing Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
 - b. Chrome-Plated Piping: One piece, steel with polished, chrome-plated finish.
 - c. Insulated Piping:
 - 1) One piece, steel with polished, chrome-plated finish.
 - 2) One piece, stainless steel with polished stainless steel finish.
 - 3) One piece, cast brass with polished, chrome-plated finish.
 - 4) One piece, stamped steel or split plate, stamped steel with concealed hinge with polished, chrome-plated finish.
 - 2. Bare Piping at Wall and Floor Penetrations in Finished Spaces:
 - a. One piece, steel with polished, chrome-plated finish.
 - b. One piece, stainless steel with polished stainless steel finish.
 - c. One piece, cast brass with polished, chrome-plated finish.
 - d. One piece, stamped steel or split plate, stamped steel with concealed hinge with polished, chrome-plated finish.
 - 3. Bare Piping at Ceiling Penetrations in Finished Spaces:
 - a. One piece, steel with polished, chrome-plated finish.

- b. One piece, stainless steel with polished stainless steel finish.
- c. One piece, cast brass with polished, chrome-plated finish.
- d. One piece, stamped steel or split plate, stamped steel with concealed hinge with polished, chrome-plated finish.
- 4. Bare Piping in Unfinished Service Spaces:
 - a. One piece, steel with polished, chrome-plated finish.
 - b. One piece, cast brass with polished, chrome-plated finish.
 - c. One piece, stamped steel or split plate, stamped steel with concealed hinge with polished, chrome-plated finish.
- 5. Bare Piping in Equipment Rooms:
 - a. One piece, steel with polished, chrome-plated finish.
 - b. One piece, cast brass with polished, chrome-plated finish.
 - c. One piece, stamped steel or split plate, stamped steel with concealed hinge with polished, chrome-plated finish.
- 6. Escutcheons for Existing Piping to Remain:
 - a. Chrome-Plated Piping: Split casting, stamped steel with concealed or exposed-rivet hinge with polished, chrome-plated finish.
 - b. Insulated Piping: Split plate, stamped steel with concealed or exposed-rivet [concealed] [or] [exposed-rivet] hinge with polished, chrome-plated finish
 - c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split plate, stamped steel with concealed or exposed-rivet hinge with polished, chrome-plated finish.
 - d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split plate, stamped steel with concealed or exposed-rivet hinge with polished, chrome-plated finish.
 - e. Bare Piping in Unfinished Service Spaces: Split plate, stamped steel with concealed or exposed-rivet hinge with polished, chrome-plated finish.
 - f. Bare Piping in Equipment Rooms: Split plate, stamped steel with concealed or exposed-rivet hinge with polished, chrome-plated finish.
- 7. Install floor plates for piping penetrations of equipment-room floors.
- 8. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
 - a. New Piping and Relocated Existing Piping: One piece, floor plate.
 - b. Existing Piping: Split floor plate.

3.02 INSTALLATION

- A. Installation of Expansion Joints, General
 - 1. Install expansion joints of sizes matching sizes of piping in which they are installed.
- B. Installation of Packless Expansion Joints
 - 1. Install metal-bellows expansion joints in accordance with EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."
 - 2. Install rubber packless expansion joints in accordance with FSA-PSJ-703.
- C. Installation of Grooved-Joint Expansion Joints
 - 1. Install grooved-joint expansion joints to grooved-end steel piping.
- D. Installation of Alignment Guides and Anchors
 - 1. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.
 - 2. Install two guides on each side of pipe expansion fittings and loops. Install guides nearest to expansion joint not more than four pipe diameters from expansion joint.
 - 3. Attach guides to pipe, and secure guides to building structure.
 - 4. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.
 - 5. Anchor Attachments:
 - a. Anchor Attachment to Steel Pipe: Attach by welding. Comply with ASME B31.9.

- b. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-58, Type 24; U bolts bolted to anchor.
 - 6. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.
 - a. Anchor Attachment to Steel Structural Members: Attach by welding.
 - b. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.
 - c. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.
- E. Installation of Pipe Loop and Swing Connections
 - 1. Connect risers and branch connections to mains with at least five pipe fittings, including tee in main.
 - 2. Connect risers and branch connections to terminal units with at least four pipe fittings, including tee in riser.
 - 3. Connect mains and branch connections to terminal units with at least four pipe fittings, including tee in main.
- F. Installation of Sleeves - General
 - 1. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
 - 2. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1 inch (25 mm) annular clear space between piping and concrete slabs and walls.
 - 3. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
 - a. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
 - b. Cut sleeves to length for mounting flush with both surfaces.
 - 1) Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level.
 - c. Using silicone sealant, seal the space outside of sleeves in floors/slabs/walls without sleeve-seal system. Select to maintain fire resistance of floor/slab/wall.
 - 4. Install sleeves for pipes passing through interior partitions.
 - a. Cut sleeves to length for mounting flush with both surfaces.
 - b. Install sleeves that are large enough to provide 1/4 inch (6.4 mm) annular clear space between sleeve and pipe or pipe insulation.
 - c. Seal annular space between sleeve and piping or piping insulation; use joint sealants that joint sealant manufacturer's literature indicates is appropriate for size, depth, and location of joint.
 - d. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Division 07 Section "Penetration Firestopping."
- G. Installation of Sleeves with Waterstop
 - 1. Install sleeve with waterstop as new walls and slabs are constructed.
 - 2. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange centered across width of concrete slab or wall.
 - 3. Secure nailing flanges to wooden concrete forms.
 - 4. Using silicone sealant, seal space around outside of sleeves. Select to maintain fire resistance of floor/slab/wall.
- H. Installation of Stack-Sleeve Fittings
 - 1. Install stack-sleeve fittings in new slabs as slabs are constructed.

- a. Install fittings that are large enough to provide 1/4 inch (6.4 mm) annular clear space between sleeve and pipe or pipe insulation.
 - b. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 076200 "Sheet Metal Flashing and Trim."
 - c. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level.
 - d. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 - e. Using silicone sealant, seal space between top hub of stack-sleeve fitting and pipe.
 2. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."
- I. Installation of Sleeve-Seal Systems
 1. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building, and passing through exterior walls.
 2. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.
- J. Installation of Fire Stop Systems
 1. Examination
 - a. Examine substrates and conditions for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of firestopping.
 2. Preparation
 - a. Surface Preparation: Clean out openings and joints immediately prior to installing firestopping to comply with recommendations of firestopping manufacturer.
 3. Installation
 - a. Install systems in accordance with manufacturer's printed installation instructions, submittals, applicable industry standards, applicable UL Systems, and governing regulatory requirements for the Work.
- K. Installation of Escutcheons
 1. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
 2. Install escutcheons with ID to closely fit around pipe, tube, and insulation of insulated piping and with OD that completely covers opening
- L. Equipment Installation - Common Requirements
 1. Install equipment to allow maximum possible headroom unless specific mounting heights are indicated or coordination with other services dictates different mounting heights. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated. Install HVAC, Plumbing, and Fire Protection equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations. Install equipment to allow right of way for piping installed at required slope.

3.03 FIELD QUALITY CONTROL

- A. Sleeves and Sleeve Seals:
 1. Perform the following tests and inspections:
 - a. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.

- b. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.
- 2. Prepare test and inspection reports.
- B. Escutcheons:
 - 1. Using new materials, replace broken and damaged escutcheons and floor plates

3.04 ERECTION OF SUPPORTS AND ANCHORAGES

- A. Metal
 - 1. Refer to Division 05 Section 05 00 00 "Metal Fabrications" for structural steel.
 - 2. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor HVAC materials and equipment.
 - a. Provide all supplementary steel to provide proper drainage for gravity flow systems.
 - 3. Field Welding: Comply with AWS D1.1/D1.1M.
- B. Wood
 - 1. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor mechanical materials and equipment.
 - 2. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
 - 3. Attach to substrates as required to support applied loads.

END OF SECTION

**SECTION 20 05 13
COMMON MECHANICAL MOTOR REQUIREMENTS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Work included:
 - 1. Starters
 - 2. Shaft Grounding
 - 3. Couplings
 - 4. Single and polyphase Motors
 - 5. Variable Frequency Motor Controllers
- B. Motors.
 - 1. Manufacturers
 - 2. General Requirements
 - 3. Motor Characteristics
 - 4. Polyphase Motors (1/2 HP (0.373 kW) and Larger)
 - 5. Single-Phase Motors (Less than 1/2 HP (0.373 kW))
 - 6. Electronically Commutated Motors:

1.02 GENERAL REFERENCES

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Contract Documents: Refer to complete set of Contract Documents for requirements that are related to or may affect the work described in this Section.

1.03 REFERENCE STANDARDS

- A. NEMA Premium Efficiency
- B. Energy Policy Act (EPACT), Minimum Motor Efficiencies
- C. ABMS 9 - Load Ratings and Fatigue Life for Ball Bearings
- D. ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings
- E. ASHRAE 90.1 - Energy Efficiency in the Design of Buildings
- F. IEEE C62.41 - Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits
- G. IEEE 112 - Test Procedure for Polyphase Induction Motors and Generators
- H. IEEE 841 - Standard for Petroleum and Chemical Industry--Premium-Efficiency, Severe-Duty, Totally Enclosed Squirrel Cage Induction Motors from 0.75 kW to 370 kW (1 hp to 500 hp); 2021.
- I. NEMA MG 00001 - Motors and Generators; 2024.
- J. CSA C22.1 - Canadian Electrical Code, Part I, Safety Standard for Electrical Installations; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- K. CSA C22.2 - General requirements — Canadian Electrical Code, Part II; x.
- L. CSA C390 - Test Method, Marking Requirements, and Energy Efficiency Levels for Three-phase Induction Motors; x.
- M. NEMA 250 - Enclosures for electrical Equipment (1000 Volts maximum)
- N. NFPA FU 1 - Low Voltage Cartridge Fuses.
- O. NEMA ICS 7 - Industrial Control and Systems: Adjustable Speed Drives.

- P. NEMA ICS 7.1 - Safety Standards for Construction and Guide for Selection, Installation, and Operation of Adjustable Speed Drive Systems.

1.04 COORDINATION

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

1.05 SUBMITTALS

- A. Action Submittals
1. Product Data:
 - a. For each type of product, excluding motors which are included in Part 1 of the plumbing equipment Sections. Submit data in conjunction with mechanical equipment served by motors
 - 1) Include construction details, material descriptions, and dimensions of individual components, and finishes.
 - 2) Include operating characteristics and furnished accessories
 - 3) Loose-shipped motors: Indicate nameplate data, standard compliance, electrical ratings and characteristics, and physical dimensions, weights, mechanical performance data, and supports points.
 - 4) Factory mounted motors: Indicate nameplate data, standard compliance, electrical ratings and characteristics, and mechanical performance data.
 2. Test Reports: Indicate procedures and results for specified factory and field testing and inspection. Data include:
 - a. Model, catalog number and modifier.
 - b. BHP, full load current, max KVAR for P.F. correction.
 - c. HP/RPM/Frame data, motor weight.
 - d. Guaranteed efficiency and power factor (P.F) at 100%, 75%, 50%, and 25% load in accordance with ANSI/IEEE 112 Test Method B.
 - e. Sound power levels measured per ANSI/NEMA MG-1.
 - f. Test results verifying nominal efficiency and power factor for three phase motors larger than 5 horsepower.
 - g. NEMA certified rating, and NEMA rating of enclosure.
 3. Submit the following product data for approval, as part of the Submittal information for the equipment and systems the motor is serving:
 - a. Manufacturer information.
 - b. Dimensions and elevations.
 - c. Complete NEMA nameplate electrical data including design type, insulation, service factor, and efficiency.
 - d. Materials of construction.
 - 1) Bearing type, L10 bearing life, and seal construction (open, single, or double shielded).
 - e. Certification that VFD driven motors comply with all parts of NEMA MG 00001 Part 31.
 4. Variable Frequency Motor Controllers:
 - a. Product Data: Submit catalog sheets showing voltage, controller size, ratings and size of switching and overcurrent protective devices, short circuit ratings, dimensions, and enclosure details. Also including
 - 1) Dimensioned outline drawing
 - 2) Schematic diagram

- 3) Component list
- 4) Power and control connection diagram(s)
- 5) NEMA rating of enclosure
- b. Shop Drawings: INDicate front and side views of enclosures with overall dimensions and weights shown; conduit entrance locations and requirements; and nameplate legends.
- c. Test Report: Indicate field test and inspection procedures and test results
- d. Manufacturer's Field Reports: Indicate startup inspection finding.
- 5. Operation and Maintenance Data: Submit instructions, complying with NEMA ICS 7.1. Include procedures for starting and operating controllers, and describe operating limits possible resulting in hazardous or unsafe conditions. Include routine preventative maintenance schedule.

1.06 QUALITY ASSURANCE

- A. Conform to ASNI / NFPA 70.
- B. UL listed
- C. Conform to efficiency requirements of local and state energy codes.
- D. All motors shall be designed, manufactured, and tested with the latest applicable standards of NEMA, IEEE and ASTM.

1.07 SOURCE QUALITY CONTROL

- A. Test motors in accordance with NEMA MG 1, including winding resistance, no-load speed and current, locked rotor current, insulation high-potential test, and mechanical alignment test.
- B. Shop inspect and perform standard production tests for each controller.
- C. Make completed controllers available for inspection at manufacturer's factory prior to packaging for shipment. Notify the owner at least seven days before inspection is allowed.
- D. Allow witnessing of factory inspections and tests at manufacturer's test facility. Notify the owner at least seven days before inspections and tests are scheduled.

1.08 COORDINATION

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

1.09 DELIVERY, STORAGE AND HANDLING

- A. Follow manufacturer's instructions and store all motors in a clean, dry space protected from weather. Maintain factory wrapping and provide additional plastic cover to protect units from dirt, water, construction debris, and traffic.
- B. Lift only with lugs provided. Handle carefully to avoid damage to components, enclosure, and finish.
- C. For extended outdoor storage, remove motors from equipment and store separately.

1.10 SUMMARY DESCRIPTION

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

- B. Section does not include motors for fire pumps, elevators, centrifugal chillers, sealed refrigeration equipment, submersible sump pumps, and vertical hollow or solid shaft motors used with vertical turbine pumps.

1.11 WARRANTY

- A. Motors:
 - 1. All materials, assemblies, components parts and performance and workmanship shall be guaranteed against defect, damage, or non-conformity for the period noted in Division 1.
 - 2. During this period the manufacturer shall make all necessary repairs or replacement to achieve conformity to specifications.
- B. Variable Frequency Controller:
 - 1. During this period the manufacturer shall make all necessary repairs or replacement to achieve conformity to specifications.

PART 2 PRODUCTS

2.01 MOTORS

- A. Manufacturers
 - 1. Baldor Electric Company
 - 2. Bell & Gossett
 - 3. Dayton.
 - 4. General Electric (GE).
 - 5. Leeson Electric.
 - 6. Marathon Electric.
 - 7. Reliance Electric.
 - 8. Toshiba Corporation.
 - 9. U.S. Electrical Motors.
- B. General Requirements
 - 1. Content includes motors for use on alternating-current power systems of up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.
 - 2. Comply with NEMA MG 00001 unless otherwise indicated.
 - 3. Comply with requirements in this Section except when stricter requirements are specified in Fire Protection, Plumbing or HVAC equipment schedules or Sections.
 - 4. Comply with CSA C22.1, CSA C22.2 and CSA C390
 - 5. Comply with IEEE 841 for severe-duty motors and for bearing life calculations. For belted applications, calculations shall be based on maximum external side load limits per NEMA MG 00001 Table 14-1A. L10 life calculations for vertical motors and horizontal motors mounted in the vertical position shall consider the application's thrust loading.
 - 6. All motors shall be suitable for non-overbearing operation, regardless of operating conditions and capable of continuous operation at full nameplate NEMA rating standards suitable for load, duty, voltage, frequency, hazard and for service and location intended. Proof of efficiency must be provided in accordance with ANSI/IEEE 112, Test Method
 - 7. Refer to schedules on drawings for required electrical characteristics. Confirm with Division 26 contractor electrical voltage, phase and starting device prior to submitting motors.
 - 8. Design for continuous non-overbearing operation under full load in 140°F (60°C) environment, with temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, hazard, and motor enclosure type.
 - 9. Capacity and TORque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

10. Motor Types:
 - a. Motors for outdoor service or in wet airstreams to be totally enclosed, epoxy sealed type, fan cooled (TEFC) motors.
 - b. General purpose motor generally inside the building to be open drip-proof (ODP) motor type, 40°C environment with Class A insulation (50°C temperature rise), and rated for continuous duty under full load.
 - c. Explosion -Proof motors when explicitly indicated in the drawings or the motor is within the airstream of product conveying exhaust system: UL approved and labeled for hazard classification, with over temperature protection.
 - d. Comply with IEEE 841 for severe-duty motors.
 11. Connections:
 - a. Wiring Terminations: Furnish terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated.
 - b. Electrical Connection: Conduit connection boxes, threaded for conduit. For fractional horsepower motors where connection is made directly, provide screwed conduit connection in end frame.
 - c. Motors shall have a power factor of 0.95 incorporating a pre-wired capacitor if required to achieve this power factor.
 - d. Where equipment is provided with control panel it shall be single point feeder, across-the-line magnetic starter, with HOA switches and overload protection.
 12. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked motor amps, frame size, manufacturer's name and model number, service factor, power factor, and efficiency.
- C. Motor Characteristics
1. Duty: Continuous duty at ambient temperature of 104 deg F (40 deg C) and at altitude of 3300 feet (1000 m) above sea level. Maximum hot spot temperature shall not exceed the insulation temperature limit, when operated in an ambient temperature of 104 deg F (40 deg C), except as otherwise indicated.
- D. Polyphase Motors (1/2 HP (0.373 kW) and Larger)
1. Description: NEMA MG 00001, Design B, medium induction motor.
 2. Efficiency: Premium Efficient, as defined in NEMA MG 00001.
 3. Service Factor: 1.15.
 4. Multispeed Motors: Variable torque.
 - a. For motors with 2:1 speed ratio, consequent pole, single winding.
 - b. For motors with other than 2:1 speed ratio, separate winding for each speed.
 5. Multispeed Motors: Separate winding for each speed.
 6. Rotor: Random-wound, squirrel cage.
 7. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
 8. Temperature Rise: Match insulation rating.
 9. Insulation: Class F.
 10. Code Letter Designation:
 - a. Motors 15 HP (11.2 kW) and Larger: NEMA starting Code F or Code G.
 - b. Motors smaller than 15 HP (11.2 kW): Manufacturer's standard starting characteristic.
 11. Enclosure Material and Bearings:
 - a. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.
 12. Additional Requirements for Polyphase Motors:
 - a. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

- b. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
 - 1) Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
 - 2) Premium-Efficient Motors: Class B temperature rise; Class F insulation.
 - 3) Inverter-Duty Motors: Class F temperature rise; Class H insulation.
 - 4) Thermal Protection: Comply with NEMA MG 00001 requirements for thermally protected motors.
 - 5) For VFD driven motors up to 100 HP, provide a maintenance free, circumferential conductive micro-fiber ground ring installed on the motor to discharge stray shaft currents to ground. Grounding ring shall be AEGIS SGR (shaft grounding ring). Motors protected by AEGIS SGR shall be warranted for the term of the manufacturer's motor warranty from induced current bearing damage.
 - 6) For VFD driven motors 100 HP and greater, provide a maintenance free, circumferential conductive micro-fiber ground ring installed on the motor to discharge stray shaft currents to ground. Grounding ring shall be AEGIS SGR (shaft grounding ring). In addition, motors shall utilize an insulated ceramic bearing assembly on the non-drive end of the motor, in conformance with the AEGIS installation requirements.
 - 7) Motors protected by AEGIS SGR shall be warranted for the term of the manufacturer's motor warranty from induced current bearing damage.
- c. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.
- E. Single-Phase Motors (Less than 1/2 HP (0.373 kW))
 - 1. Motors larger than 1/20 HP (37 W) shall be one permanent-split-capacitor type, to suit starting torque and requirements of specific motor application:
 - a. Permanent-split capacitor.
 - b. Split phase.
 - c. Capacitor start, inductor run.
 - d. Capacitor start, capacitor run
 - 2. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
 - 3. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
 - 4. Motors 1/20 HP (37 W) and Smaller: Shaded-pole type.
 - 5. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.
 - 6. Furnish with sliding base/slotted mounting holes adequate for proper belt tensioning and alignment of motor or motor/load.
- F. Electronically Commutated Motors:
 - 1. Microprocessor-Based Electronic Control Module: Converts 120 V or 240 V single-phase AC power to three-phase DC power to operate the brushless DC motor.
 - 2. Three-phase power motor module with permanent magnet rotor.
 - 3. Circuit board or digital speed controller/LED display.
 - 4. Building Automation System Interface: Via AC voltage signal, DC voltage signal, or Digital Serial Interface (DSI).
- G. Couplings:
 - 1. Direct drive couplings to be flexible, self-aligning, non-lubricating type rating for 125% of load, and shall be totally enclosed with heavy gage steel guards per OSHA requirements,

2. Where belt drives are the only available option, include OSHA belt guards and motor slide rails, and coordinate the TAB contractor responsible for final belt adjustment for balancing. Provide V-belts of proper number and size, complete with the required grooved sheaves and other requisite accessories. If used for smoke control or emergency ventilation, belt drive shall incorporate 1.5 times the number of belts required for the design duty with the minimum number of belts being two. The motors driving fans shall not be operated beyond the name plate horsepower determined from measurement of actual current draw. These requirements equivalent to the motor and drive requirements used for smoke control fans for an international level of redundancy.

H. Guards

1. All rotating elements on equipment shall have protective devices in accordance with the OSHA requirements.
 - a. Coupling guards shall completely enclose the rotating coupling and shall be constructed of heavy gage steel.
 - b. Belt guards shall totally enclose the belts and sheaves. Guards shall be fabricated of 16 gauge galvanized expanded metal sides with 70% free area, solid galvanized steel band and adequately sized galvanized angle iron frame. Outdoor belt guards shall be solid metal with stamped out louvers at top and bottom for ventilation. Adequate room for belt adjustment shall be provided. Tachometer holes with covers shall be provided for both sheaves.

2.02 ELECTRIC MOTOR STARTERS

- A. Manufacturers: there shall be only one electric motor starter manufacturer for mechanical equipment allowed on the job:
1. Allen Bradley Co
 2. Square D
 3. General Electric
 4. Or approved equal.

2.03 VARIABLE FREQUENCY CONTROLLER

- A. Variable frequency drives shall be provided on fans and motors as scheduled. Maximum speed adjustment from 60% to 100% and minimum speed adjustment from 0% to 100%. Provide Hand-Off-Auto selector switch, digital speed settings, Auto/Manual selector switch, readouts for motor speed, motor amps, motor volts, % load, LED indicators for Power, Fault, and "at set speed". Provide automatic overload sensing. Provide NEMA enclosure rating as required later in the section based on installation location. Provide integral line reactors. Provide 3-sets of spare dry contacts besides the connections required for the sequence of operation.
- B. Variable frequency drive to be by a single manufacturer and shall conform to ANSI/NFPA 70.
- C. Manufacturer: there shall be only one VFD manufacturer allowed on the job as listed below:
1. Reliance
 2. ABB
 3. Baldor
 4. Toshiba
 5. Eaton
 6. Or approved equal.
- D. Variable Frequency Drives shall incorporate a DC bus inductor, 5% integral line reactors and shall produce no more than 3% total harmonic distortion when operating alone to provide harmonic filtration. Variable frequency drives shall include a 12-pulse rectifier for all motors greater than 20HP and less than 50HP.
- E. Product Description: NEMA ICS 7, enclosed variable frequency controller suitable for operating indicated loads. Select unspecified features and options in accordance with NEMA ICS 7.1

PART 3 EXECUTION

3.01 EXISTING WORK

- A. Disconnect and remove abandoned motors
- B. Maintain access to existing motors and other installations remaining active and requiring access. Modify installation or provide access panel.
- C. Clean and repair existing motors to remain or are to be reinstalled.

3.02 EXAMINATION

- A. Verify that building environment can be maintained within the service and ambient temperature and humidity ratings required by the VFD manufacturer.

3.03 INSTALLATION

- A. Ensure access to existing motors and other installations which remain active and which require access. Modify installation or provide access panel as appropriate.
- B. Install and align motors in accordance with the equipment manufacturer's recommendations.
- C. For VFD driven motors using a shaft grounding ring: Install grounding ring in accordance with the manufacturer's recommendations, including application of a colloidal silver shaft coating on the motor shaft.

3.04 FIELD TESTING

- A. Test existing motors which are designated to be controlled with new adjustable speed drives as follows:
 - 1. Visual Inspection for:
 - a. Signs of thermal aging.
 - 2. Contamination of coil and connection surfaces.
 - a. Signs of mechanical stress.
 - b. Evidence of corona discharges for motors operating in excess of 600 volts.
 - 3. Insulation for conformance to IEEE Standard 43.
 - 4. Polarization index for conformance to IEEE Standard 43. (Note: Recommended minimum value for Class B or higher winding is 2.0)
 - 5. Vibration Analysis, for motor bearing condition and shaft alignment. Test shall be in accordance with NEMA MG107.
 - 6. Full load ampere test

3.05 ADJUSTING

- A. Assure motor nameplate is legible and properly affixed.
- B. Verify bearings are factory lubricated before starting motors. Lubricate per manufacturer's instructions. Do not over lubricate bearings.
- C. Check motors for unusual heating, noise, or excessive vibration during operation. Correct any such deficiencies.
 - 1. Any motors with vibration exceeding specified limits, as noted in the Testing, Adjusting, and Balancing Section, or manufacturer's recommendations, whichever is more stringent, shall be corrected, at no cost to the Owner, until reduced below those limits.
- D. Clean the motor prior to start-up and immediately prior to final turn-over to the Owner.

3.06 CLEANING

- A. Clean and repair existing motors which remain or are to be installed.

3.07 COMMISSIONING

- A. Perform commissioning activities as outlined in Division 1 Section, Commissioning Requirements, and other requirements of the Contract Documents.

END OF SECTION

SECTION 20 05 14
VARIABLE-FREQUENCY MOTOR CONTROLLERS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Manufacturers
 - 1. A.B.B.
 - 2. Danfoss.
 - 3. Yaskawa Electric America.
- B. General
 - 1. Unit shall be dead front construction.
 - 2. All relays shall be a plug-in style base.
 - 3. All fuses shall be mounted in fuse blocks with insulated covers. Covers shall shield fuse ends and wire terminations.
 - 4. The VFD shall be marked with its short circuit current rating in compliance with UL.
 - 5. The unit, including all specified accessories, shall have a minimum efficiency of 85% at any speed from 50 to 100%. The unit shall have a power factor of 0.9 or higher when operating at any speed from 50 to 100%.
 - 6. The VFD shall be a variable torque type and shall provide full motor torque at any operating speed from 40 to 100%.
 - 7. The VFD shall provide variable torque V/Hz control when operating at speeds less than 100%.
 - 8. The VFD must be capable of operating in the following service conditions
 - 9. Provide the drive with a main input disconnect switch, accessible without opening the drive cabinet, equipped with current limiting fuses and fuse rejection clips, or circuit breakers. All other fuse blocks with current limiting fuses installed shall be equipped with fuse rejection clips. It shall be possible to padlock the disconnect in the "off" position.
 - 10. Provide minimum 6 pulse-width modulation (PWM) type drives.
 - 11. the motor's across-the-line noise at any motor speed from 50 to 100%
 - 12. The unit shall include self-diagnostics with a digital display that identifies fault conditions and trouble shooting. Fault indication shall be retained even after a power outage or an input over-current protective device trip.
 - 13. Unit shall be provided with RFI/EMI filters.
 - 14. VFD shall include current sensors on all three output phases to accurately measure motor current.
 - 15. Provide minimum 3% AC input line reactors and/or minimum 5% DC link reactors to limit the maximum current total harmonic distortion (THD) to not more than 100% of the variable frequency drive (VFD) input current waveform at any VSD operating speed from 20 to 100%. Reactors shall be integral to the VFD. The reactors shall not be active when the drive is in the bypass mode. If testing reveals the maximum THD is exceeded, the manufacturer shall provide and install additional reactors at no cost to reduce the THD to within these specified limits.
 - 16. The unit shall have a dedicated terminal block for all external inputs and outputs.
 - 17. Provide a factory mounted and wired 115 V, 1 Ph, 60 Hz control power transformer sized for handling an additional 30 VA inductive load. Limit fuse size for the control transformer to 3 amps maximum.
 - 18. The VFD input and output shall be rated at 480-volt, 3 phase or 208-volt, 3 phase
 - 19. The VFD shall have a minimum short circuit current rating (SCCR) of 100 kA.
 - 20. Provide a factory mounted and wired manual bypass device.
 - 21. Provide two (2) 3-position selector switches to control bypass contactor and the VFD input and output contactors
 - 22. Control Features

- 23. Indicators
- 24. Safeties

1.02 GENERAL REFERENCES

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Contract Documents: Refer to complete set of Contract Documents for requirements that are related to or may affect the work described in this Section.

1.03 RELATED REQUIREMENTS

- A. 21 31 13 - Fire Pumps, Pressure Maintenance Pumps, and Controllers for adjustable-speed drive fire pump controllers.

1.04 REFERENCE STANDARDS

- A. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.05 SUBMITTALS

- A. Action Submittals
 - 1. Product Data: Provide manufacturer's standard catalog pages and data sheets for motor controllers, enclosures, overcurrent protective devices, and other installed components and accessories.
 - 2. Shop Drawings: Indicate dimensions, voltage, controller sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
 - a. Include dimensioned plan and elevation views of controllers and adjacent equipment with required clearances indicated.
 - b. Include wiring diagrams showing factory and field connections.
 - c. Identify mounting conditions required for equipment seismic qualification.
 - 3. Derating Calculations: Indicate ratings adjusted for applicable service conditions.
 - 4. Specimen Warranty: Submit sample of manufacturer's warranty.
 - 5. Manufacturer qualification statement.
 - 6. Installer qualification statement.
 - 7. Maintenance contractor qualification statement, if different entity from installer.
 - 8. Manufacturer's equipment seismic qualification certification.
 - 9. Manufacturer's certification that products meet or exceed specified requirements.
 - 10. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
 - 11. Source quality control test reports.
 - 12. Manufacturer's detailed field testing procedures.
 - 13. Field quality control test reports.
 - 14. Executed Warranty: Submit documentation of final executed warranty completed in Owner's name and registered with manufacturer.
 - 15. Maintenance contracts.
 - 16. Required Embodied Carbon Submittals: All products which satisfy one of the following criteria will require an Embodied Carbon Submittal:
 - a. The product is a 'Major' piece of equipment
 - b. The product contains refrigerant
 - c. The cost of a group of products serving a given function constitutes 5% or greater of the sub-contractor's budget, excluding labor.
 - 17. Embodied Carbon Submittals

- a. Order of Preferred Submittals: For products which require an embodied carbon submittal (described above), one of the following must be provided. The submittal must be that with the highest preference available. The order preference, from highest to lowest is:
 - 1) Product Specific, Facility Specific EPD
 - 2) Product Specific EPD
 - 3) Industry Average EPD
 - 4) TM65 Manufacturer Form with Mid-Level Calculation data
 - 5) TM65 Manufacturer Form with Basic Calculation data
- B. Operation and Maintenance Materials
 - 1. Operation and Maintenance Data: Include detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.
 - a. Include contact information for entity providing contract maintenance and trouble call-back service.
- C. Record Documents
 - 1. Record actual installed locations of controllers and final equipment settings.
 - a. Include nameplate data of actual installed motors and associated overload relay selections and settings.
 - b. Motor Circuit Protectors: Include magnetic instantaneous trip settings.

1.06 WARRANTIES

- A. Provide minimum 18 month manufacturer warranty covering repair or replacement due to defective materials or workmanship.

1.07 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Maintain copy of each referenced document that prescribes execution requirements at project site.
- C. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
 - 1. Authorized service facilities located within 200 miles (320 km) of project site.
- D. Installer Qualifications: Company with minimum three years documented experience with variable-frequency motor control systems of similar size, type, and complexity; manufacturer's authorized installer.
- E. Maintenance Contractor Qualifications: Same entity as installer or different entity with specified qualifications.
 - 1. Contract maintenance office located within 200 miles (320 km) of project site.
- F. Product Listing Organization Qualifications: Organization recognized by OSHA as Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.
- G. Tests shall be included in the manufacturers bid. Certification that the factory inspections and load tests have been successfully performed shall be submitted to the Owner after completion of the tests.

1.08 PRE-INSTALLATION TESTING

- A. Coordinate work to provide motor controllers suitable for use with actual motors to be installed.
- B. Coordinate work to provide controllers and associated wiring suitable for interface with control devices to be installed.
- C. Coordinate arrangement with dimensions and clearance requirements of actual equipment to be installed.

- D. Verify with manufacturer that conductor terminations are suitable for use with conductors to be installed.
- E. Notify Architect of conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.09 DELIVERY, STORAGE AND HANDLING

- A. Store in clean, dry space. Maintain factory wrapping or provide additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to internal components, enclosure, and finish.

1.10 EXTRA MATERIALS

- A. Furnish following for Owner's use in maintenance of project.
 - 1. Electronic Trip Circuit Breakers: Provide one portable test set.
 - 2. Indicating Lights: Two of each different type.
 - 3. Air Filters: Two of each different type.
 - 4. See Section 26 28 13 for requirements for spare fuses and spare fuse cabinets.

1.11 SUMMARY DESCRIPTION

- A. Variable-frequency motor controllers for low-voltage (600 V and less) AC motor applications.
- B. Overcurrent protective devices for motor controllers, including overload relays.

1.12 FIELD CONDITIONS

- A. Maintain field conditions within required service conditions during and after installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. A.B.B.
- B. Danfoss.
- C. Yaskawa Electric America.

2.02 GENERAL

- A. Unit shall be dead front construction.
- B. All relays shall be a plug-in style base.
- C. All fuses shall be mounted in fuse blocks with insulated covers. Covers shall shield fuse ends and wire terminations.
- D. The VFD shall be marked with its short circuit current rating in compliance with UL.
- E. The unit, including all specified accessories, shall have a minimum efficiency of 85% at any speed from 50 to 100%. The unit shall have a power factor of 0.9 or higher when operating at any speed from 50 to 100%.
- F. The VFD shall be a variable torque type and shall provide full motor torque at any operating speed from 40 to 100%.
- G. The VFD shall provide variable torque V/Hz control when operating at speeds less than 100%.
- H. The VFD must be capable of operating in the following service conditions:
 - 1. Ambient Temperature: 0 deg to 40 deg C (32 deg to 104 deg F).
 - 2. Relative Humidity: 0 to 95%, non-condensing.
 - 3. Elevation: 0 to 3300 ft (100 meters) above mean sea level (MSL).
 - 4. AC line voltage variation:
 - a. 480 V: 440 - 10% to 500 + 10%; 45-65 Hz
 - b. 230 V: 200 - 10% to 230 + 10%; 45-65 Hz

- I. Provide the drive with a main input disconnect switch, accessible without opening the drive cabinet, equipped with current limiting fuses and fuse rejection clips, or circuit breakers. All other fuse blocks with current limiting fuses installed shall be equipped with fuse rejection clips. It shall be possible to padlock the disconnect in the "off" position.
- J. Provide minimum 6 pulse-width modulation (PWM) type drives.
- K. the motor's across-the-line noise at any motor speed from 50 to 100%.
- L. The unit shall include self-diagnostics with a digital display that identifies fault conditions and trouble shooting. Fault indication shall be retained even after a power outage or an input over-current protective device trip.
- M. Unit shall be provided with RFI/EMI filters.
- N. VFD shall include current sensors on all three output phases to accurately measure motor current.
- O. Provide minimum 3% AC input line reactors and/or minimum 5% DC link reactors to limit the maximum current total harmonic distortion (THD) to not more than 100% of the variable frequency drive (VFD) input current waveform at any VSD operating speed from 20 to 100%. Reactors shall be integral to the VFD. The reactors shall not be active when the drive is in the bypass mode. If testing reveals the maximum THD is exceeded, the manufacturer shall provide and install additional reactors at no cost to reduce the THD to within these specified limits.
- P. The unit shall have a dedicated terminal block for all external inputs and outputs.
- Q. Provide a factory mounted and wired 115 V, 1 Ph, 60 Hz control power transformer sized for handling an additional 30 VA inductive load. Limit fuse size for the control transformer to 3 amps maximum.
- R. The VFD input and output shall be rated at 480-volt, 3 phase or 208-volt, 3 phase.
- S. The VFD shall have a minimum short circuit current rating (SCCR) of 100 kA.
- T. Provide a factory mounted and wired manual bypass device.
 - 1. Manual Bypass
 - a. Manual transfer to line power shall be via three (3) contactors sized for applicable voltage and motor current. One (1) contactor shall be between the VFD output and the motor. The second shall be between the bypass power line and the motor, providing across-the-line starting. The third contactor shall be between the line voltage and VFD input. Transferring load via contactors shall disconnect VFD inputs from line voltage and outputs from the motor, thus providing the ability to safely trouble shoot and test the VFD while operating in the bypass mode. A fused disconnect switch shall be required. Bypass and VFD output contactors shall be electrically and mechanically interlocked to prevent both being closed at the same time. Include motor thermal overload protection in bypass and VFD modes.
- U. Provide two (2) 3-position selector switches to control bypass contactor and the VFD input and output contactors: 1) Normal-Off-Test and 2) Drive-Off-Bypass. Selector switches shall have padlockable switch covers.
 - 1. Door mounted status lights shall include power on, drive, bypass, and safety.
 - 2. Provide terminal strip for connection of fire, smoke contacts, external start command, and VFD control signal. All external interlocks shall function in hand, auto, or bypass. External start/stop signal shall be functional in auto and bypass modes.
 - 3. The 120-volt ac control power shall be supplied by the fused transformer.
 - 4. Provide a NEMA 1 enclosure for bypass components and a NEMA 4 enclosure is required for outdoor applications. Bypass and VFD enclosures shall be factory wired and assembled on a common backplate.
 - 5. Manual bypass and accessories shall be furnished and mounted by the VFD manufacturer.

6. Two (2) contactor bypasses and knife switches are not acceptable.
7. The bypass device shall allow the load to run across-the-line while electrically isolating the VFD so that maintenance can be performed on the drive components.

V. Control Features

1. The VFD shall be provided with the following control features:
 - a. Factory mounted and wired Hand-Off-Auto selector switch that allows local or remote starting or stopping of the drive. Separate start and stop buttons, electronic circuits that "virtually" provide this capability or other alternative devices are not acceptable.
 - b. Factory mounted and wired VFD-Bypass switch.
 - c. Factory mounted and wired Local-Remote speed control switch, that allows either local or remote control of the drive speed. Key pad buttons are also acceptable provided that permanently labeled, dedicated buttons are provided for the local and the remote speed control functions.
 - d. Main input disconnect switch.
 - e. Inverter input and output disconnect switch, accessible without opening the drive cabinet, if a bypass device is provided.
 - f. Manual speed potentiometer or keypad control, for local speed control with the Local-Remote speed control switch in the Local position.
 - g. VFD shall accept an input reference (feedback) signal, 4-20 mA analog input, for remote speed control with the Local-Remote speed control switch in the Remote position. Provide input signal; isolation to isolate input signal ground from the VFD internal ground control. Coordinate required 4-20 mA analog input with DDC control system supplier.
 - h. A remote start/stop contact input that functions in the automatic mode only.
 - i. A safety interlock circuit that functions in drive and bypass modes. All safety and limit controls must function in both automatic and manual operating modes.
 - j. A run permissive circuit, separate from the safety interlock circuit, which prevents motor operation whether in drive or bypass mode. This circuit, via the customer's external contact device, signals the motor may run, provided the safety interlock contact(s) is made. A typical application would be for a time delay before motor start to allow some external event to occur. The run permissive circuit shall be jumpered from the factory.
 - k. Provide the following drive initiated external circuits:
 - 1) Powered run mode: A circuit that is powered after the motor is started in drive or bypass modes.
 - 2) Powered run request: A circuit that is powered whenever the drive safety interlock contact(s) are closed, and the drive H-O-A is in hand, or the drive H-O-A is in auto and the remote start/stop contact is closed.
 - l. A standard USB port for direct connection of a Personal Computer (PC) to the VFD. The manufacturer shall provide PC software to allow complete setup and access to the VFD through the USB port. It shall be possible to communicate to the VFD through this USB port without interrupting VFD communications to the Building Management System (BMS).
 - m. An integral proportional-integral-derivative (PID) controller that, when activated, controls drive speed to maintain a programmed set point based on a remote analog input feedback signal.
 - 1) The VFD shall be able to apply a scaling factor to the feedback signal.
 - 2) The VFD shall be able to calculate the square root of the feedback signal so that a pressure sensor can be used to measure flow.
 - 3) The analog feedback signal must be linear in nature when inputting to the on-board (PID) controller using this feature.
 - n. A real-time clock shall be an integral part of the VFD.

- 1) It shall be possible to use this to display the current date and time on the VFD's display.
- 2) The clock shall include a time clock function with 7-day programmability and a minimum of four (4) programmable time periods per day, with individually selectable ON and OFF functions. The time clock function shall be programmable to control start/stop functions, constant speeds, PID parameter set points and output relays. The time clock function shall be programmable through the controller display and keypad, or by included software that allows programming via a PC and a USB connection.
- o. VFD shall be capable of starting a coasting load. Provide a bi-directional auto speed search to allow starting into rotating loads spinning in either direction.
- p. VFD shall automatically attempt to restart a minimum of three (3) times during an adjustable time period of no less than 30 seconds after shutting off for any reason, except for a short circuit or motor overload.
- q. The VFD shall have adjustable motor acceleration and deceleration rates from 0.1 to 1,800 seconds. Provide maximum Hz speed settings. Provide current limiting feature.
- r. The VFD shall have the ability to lock-out a minimum of four (4) critical frequency ranges to prevent the VFD from operating the load at a speed that causes vibration in the driven equipment.
- s. The VFD shall be configured as required to meet system operational requirements including:
 - 1) Provide one (1) normally open and one (1) normally closed auxiliary contacts to actuate when the motor is started in any mode.
 - 2) Provide an additional set of N.O. contacts on the VFD-bypass switch that close when the switch is set to bypass.
 - 3) Provide a minimum of one (1) 4-20 mA analog output signal selectable to proportionally indicate drive output frequency, current, or power, or to indicate the VFD input reference/feedback signal, for monitoring by the DDC control system or the Building Management System.
 - 4) Provide remote communication to the building DDC/BMS control system.
 - (a) The drive shall be configured to communicate with several different fieldbuses, making it easy to communicate with a variety of control systems. Fieldbus options are as follows:
 - (1) BACnet
 - (2) N2 / Modbus
 - (3) LonWorks
 - (b) The DDC system shall be capable of receiving all VFD fault and trips, current, voltage, and power consumption through the communication interface. The communication capabilities shall include but not be limited to the following:
 - (1) Output Frequency / Speed
 - (2) Motor Current
 - (c) Output voltage
 - (1) Motor Power (kW)
 - (2) Analog Input Valves
 - (3) Drive Status
 - (4) Motor Speed / Torque
 - (5) Run Time
 - (6) Accel / Decel Time Adjustments
 - (7) VFD Fault Status
 - (8) Start / Stop Control (if not required to be hardwired)

W. Indicators

1. Provide an indicating lamp for "POWER AVAILABLE" and for "MOTOR ON BYPASS". Lights shall be LED type.
 2. A motor RPM and AMP display shall be factory mounted on the face of the unit, either as a separate indicator or via the controller display.
- X. Safeties
1. Provide LED type status lights or digital display indication of the cause of any shutdown.
 2. The VFD shall be provided with the following safety features:
 - a. VFD over voltage and under voltage protection and protection against temporary power outages.
 - b. VFD over temperature protection.
 - c. Motor over temperature protection per NEC 430.126(A) (2).
 - d. Short circuit and ground fault protection.
 - e. Separate motor overload protection functional in bypass and normal operation. For VFD's controlling multiple motors, provide overload protection for each motor.
 - f. Integral phase-loss protection
 - g. Adjustable current limiter.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Unit installation, including mounting, supports, and wiring to motor, shall be by the Electrical Trades, in compliance with Division 26. Coordinate with the Mechanical Trades and the Control Trades, as required.
- B. Install the VFD as close as possible to the motor. The load side power cables to the motor shall be kept as short as possible and shall not be run in the same conduit as the line side power cables. Control wiring shall be in separate conduit from power wiring. Where applicable, control wires from the motor disconnect early break contacts may be installed with the motor power wiring.
- C. Provide "shaft grounding" since modern AC or DC variable speed motors develop an electrical potential between the shaft and the frame of the motor. It has been found that shaft-to-frame voltages above three (3) volts generally cause current flow across the bearings. When current flows across a bearing, metal is transferred causing frosting, pitting, and fluting of the bearing races resulting in premature failure of the bearings. Grounding the shaft to the frame provides a path for the current to flow around the bearings eliminating the bearing damage caused by shaft potentials. Therefore, all installed VFD's shall include a shaft grounding brush as manufactured by "Shaft Grounding Systems, Inc." (SGS) on all fan and pump motors. The products manufactured by SGS contain only stable materials and are not believed to constitute a hazardous material as defined under the Office of Safety and Health Act (OSHA) regulations. Specifically developed proprietary carbon compounds are used by SGS to ensure sustained performance. At present, the brush wear life expectancy is from 3 to 5 years based upon data obtained from running these brushes for over two (2) years in continuous industrial applications. In systems designed for wet or severe environment applications, the brush contact area shall be sealed to keep contaminants from entering the shaft grounding system. The shaft grounding system shall be designed to reduce shaft voltage levels to less than the three (3) volts typically required for current to pass through bearings. Shaft voltages without a shaft grounding system typically range from 3 to 30 volts, or higher.
- D. Protect the unit from dirt, dust, water, and physical damage prior to and during construction. If the inside of the unit becomes dirty or dusty before acceptance by the Owner, it shall be thoroughly cleaned by the unit manufacturer at the contractor's expense.

3.02 FIELD QUALITY CONTROL

- A. Check, Test and Start

1. After installation of the system at the site a field acceptance test shall be performed by the Mechanical trades in conjunction with the manufacturer of the drive equipment, who will provide the services of a factory trained and certified technician to supervise the check, test and start.
2. The mechanical contractor shall notify the Owner's representative five (5) days prior to the start-up procedure.
3. The field acceptance test shall consist of a repeat of the factory test. Functional tests shall demonstrate satisfactory operation of all interlocks, alarms, and normal operational sequences. The drive manufacturer shall use suitable test equipment to locate and correct all malfunctions. Repeated failure of any component will cause the test to be terminated and restarted when the equipment has been fixed. Harmonic distortion tests shall be run on the drives and the bus to determine the voltage and current distortion. IEEE 519-1992 standards shall be used as the guide to test results. Measurements shall be made utilizing a Dranetz analyzer or a BMI analyzer capable of indicating snapshots of the current and voltage distortions. Measurements shall include phase to phase, phase to neutral, and neutral to ground. The test shall be run the full range of the drive operation. The graphs of the test results shall be submitted for speed values of 60%, 80%, and 100%. Also, test shall be done with no units running, then one unit, then two units, etc. Tests shall be conducted by a qualified technician acceptable to the Owner. Included in the scope of this specification shall be an allowance for a factory-trained service engineer, other than sales representatives, to inspect, perform final adjustments and operational checks, perform functional checks, and prepare a final report for record purposes. A minimum of one day shall be allowed for this start-up service.
4. The "Capacity Test" to insure that energy use is minimized, the HVAC system must be balanced at design conditions at the lowest possible static pressure (SP). This requires that the lowest possible SP be found at the sensor that will allow full design flow at the Terminal Air Unit (TAU) most difficult to satisfy. This system minimum SP found is what the VFD should control to. To accomplish this verify that the TAU on the critical leg has its damper 90% or more open when all TAU's taking off upstream of the static pressure sensor are in full cooling. The "Capacity Test" to minimize energy usage in the hydronic system, it must be balanced at design conditions at the lowest differential pressure (DP) possible. This requires that the lowest possible DP at the sensor be found that will allow the delivery of design flow through the valve most difficult to satisfy. This system minimum DP found is what the VFD should control to. This is accomplished by changing the temperature setpoint for all zones to 55 deg F for cooling or 85 deg F for heating coils, causing all AHU coil valves to be calling for full cooling or heating, as applicable. Each coil's flow is then measured against the design flow. The coil that is receiving the lowest the lowest fraction of design is identified. The current DP at the controlling sensor is noted. A calculation is made, giving the DP required at the sensor to allow the identified most critical coil to meet its design flow.
5. The Mechanical trades shall submit a "Certificate of Proper Installation" to the Owner confirming that all equipment was inspected, operation checked, and installation approved in writing by the manufacturer's representative.
6. UNDER NO CIRCUMSTANCES ARE ANY PORTIONS OF THE VARIABLE FREQUENCY DRIVE SYSTEM TO BE ENERGIZED WITHOUT AUTHORIZATION FROM THE MANUFACTURER'S REPRESENTATIVE.

3.03 IDENTIFICATION

- A. Labeling
 1. Provide engraved plastic labels permanently attached to the VFD panel face indicating the unction of all switches and indicators, and the equipment served.
 2. Tag all wiring in the drive. Tag nomenclature shall match the corresponding wire identification nomenclature indicated on the approved drive submittal.

3. For VFD's serving smoke purge, stair pressurization, or other smoke control systems, include an engraved permanently attached red faced label, minimum 8" x 8", with the following nomenclature: "CAUTION: THIS VFD IS PART OF A LIFE SAFETY SMOKE CONTROL SYSTEM. NOTIFY THE OWNER PRIOR TO ANY CHANGE OR MAINTENANCE ACTIVITY TO THIS DRIVE".

3.04 DEMONSTRATION AND TRAINING

- A. Conduct a minimum of four (4) hours training for maintenance staff on operation, programming, and service of VFD's. Training shall be conducted by a factory trained service technician.
- B. Training shall not be performed until system is operational and functional and two (2) weeks after receiving approved job specific technical manuals.

END OF SECTION

**SECTION 20 05 19
METERS AND GAUGES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Thermometers.
 - 1. Bimetallic-Actuated Thermometers - HVAC and Plumbing Piping
 - 2. Filled-System Thermometers
 - 3. Liquid-In-Glass Thermometers
 - 4. Light-Activated Thermometers
 - 5. Duct-Type, Liquid-In-Glass Thermometers - HVAC Piping Only
- B. Duct-Thermometer Mounting Brackets
 - 1. Description
- C. Thermowells.
 - 1. Thermowells – HVAC and Plumbing Piping
 - 2. Heat-Transfer Medium
 - 3. Manufacturers
- D. Pressure Gages
 - 1. Direct-Mounted Pressure Gages – Plumbing Piping
 - 2. Remote-Mounted Pressure Gages
- E. Gage Attachments
 - 1. HVAC
 - 2. Plumbing
- F. Test Plugs
 - 1. Manufacturers
 - 2. Source Limitations
 - 3. Description
 - 4. Body
 - 5. Thread Size
 - 6. Minimum Pressure and Temperature Rating
 - 7. Core Inserts
 - 8. Plumbing Piping Requirements
- G. Test-Plug Kits
 - 1. Manufacturers
 - 2. Source Limitations
 - 3. Furnish one test kit(s) containing one pressure gage and adaptor, one thermometer(s), and carrying case. Pressure gage, adapter probes, and thermometer sensing elements shall be of diameter to fit test plugs and of length to project into piping.
 - 4. Low-Range Thermometer
 - 5. High-Range Thermometer
 - 6. Pressure Gage
 - 7. Carrying Case
 - 8. Plumbing Piping Requirements
- H. Sight Flow Indicators
 - 1. Manufacturers
 - 2. Source Limitations
 - 3. Description
 - 4. Construction
 - 5. Minimum Pressure Rating

6. Minimum Temperature Rating
7. End Connections for NPS 2 (DN 50) and Smaller
8. End Connections for NPS 2-1/2 (DN 65) and Larger
9. Plumbing Piping Requirements
- I. Flowmeters
 1. Orifice Flowmeters
 2. Pitot-Tube Flowmeters
 3. Turbine Flowmeters
 4. Venturi Flowmeters
 5. Vortex-Shedding Flowmeters
- J. Thermal-Energy Meters
 1. Impeller-Turbine, Thermal-Energy Meters
 2. Ultrasonic, Thermal-Energy Meters
- K. Insertion-Turbine, Thermal-Energy Meter Systems
 1. Manufacturers
 2. Description
 3. Flow Sensor
 4. Meter

1.02 GENERAL REFERENCES

- A. Contract Documents: Refer to complete set of Contract Documents for requirements that are related to or may affect the work described in this Section.
- B. Division 20, including all Common Mechanical Requirements in Section 20 00 00, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.

1.03 RELATED REQUIREMENTS

- A. Section 21 10 00 - Water-Based Fire-Protection Systems for pressure gages for use on fire protection systems.
- B. Section 22 10 06 "Plumbing Piping Specialties" for water meters.
- C. Section 22 15 13 "General-Service Compressed-Air Piping" for compressed air gauges.
- D. Section 23 09 23 - Direct-Digital Control System for HVAC.
- E. Section 23 09 43 - Pneumatic Control System for HVAC.
- F. Section 23 09 93 - Sequence of Operations for HVAC Controls.
- G. Section 23 21 13 - Hydronic Piping.
- H. Section 23 22 13 - Steam and Condensate Heating Piping.
- I. Section 33 14 15 "Site Water Distribution Piping" for domestic water meters and combined domestic and fire-protection water-service meters outside the building

1.04 REFERENCE STANDARDS

- A. ASME B40.1 - Gauges - Pressure Indicating Dial Type - Elastic Element
- B. ASME Section VIII - Boiler and Pressure Vessel Code - Pressure Vessels
- C. ASTM E1 - Standard Specification for ASTM Thermometers.
- D. ASTM E77 - Standards Test Method for Inspection and Verification of Thermometers.
- E. UL 393 - Indicating Pressure Gauges for Fire-Protection Service.
- F. UL 404 - Gauges, Indicating Pressure, For Compressed Gas Service.
- G. ASME B1.1 - Unified Inch Screw Threads (UN, UNR, and UNJ Thread Forms); 2024.

- H. ASME B1.20.1 - Pipe Threads, General Purpose, Inch; 2013 (Reaffirmed 2018).
- I. ASME B40.100 - Pressure Gauges and Gauge Attachments; 2022.
- J. ASME B40.200 - Thermometers, Direct Reading And Remote Reading; Approved Edition.
- K. NSF 61 - Drinking Water System Components - Health Effects; 2024.
- L. NSF 372 - Drinking Water System Components - Lead Content; 2024.

1.05 DEFINITIONS

- A. Existing Piping to Remain: Existing piping that is not to be removed and that is not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.
- B. CR: chlorosulfonated polyethylene synthetic rubber.
- C. EPDM: Ethylene-propylene-diene terpolymer rubber.

1.06 PERFORMANCE REQUIREMENTS

- A. Domestic water expansion fittings and loops for plumbing piping intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act, with requirements of authorities having jurisdiction, and with NSF 61 and NSF 372, or be certified in compliance with NSF 61 and NSF 372 by an ANSI-accredited third-party certification body, in that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.
- B. Compatibility: Provide products suitable for piping service fluids, materials, working pressures, and temperatures.
- C. Capability: Provide products and installations to accommodate maximum axial movement as scheduled or indicated on Drawings

1.07 SUBMITTALS

- A. Action Submittals
 - 1. Product Data: Provide list that indicates use, operating range, total range and location for manufactured components.
 - 2. Shop Drawings: Schedule for thermometers, gages, flowmeters, and thermal-energy meters indicating manufacturer's number, scale range, and location for each.
 - 3. Product Certificates: For each type of thermometer, signed by product manufacturer.
 - 4. Required Embodied Carbon Submittals: All products which satisfy one of the following criteria will require an Embodied Carbon Submittal:
 - a. The product is a 'Major' piece of equipment
 - b. The product contains refrigerant
 - c. The cost of a group of products serving a given function constitutes 5% or greater of the sub-contractor's budget, excluding labor.
 - 5. Embodied Carbon Submittals
 - a. Order of Preferred Submittals: For products which require an embodied carbon submittal (described above), one of the following must be provided. The submittal must be that with the highest preference available. The order preference, from highest to lowest is:
 - 1) Product Specific, Facility Specific EPD
 - 2) Product Specific EPD
 - 3) Industry Average EPD
 - 4) TM65 Manufacturer Form with Mid-Level Calculation data
 - 5) TM65 Manufacturer Form with Basic Calculation data
- B. Project Record Documents: Record actual locations of components and instrumentation.

- C. Operation and Maintenance Data: Submit instructions for calibrating instruments, installation instruction, assembly views, servicing requirements, lubrication instruction, and replacement parts list.
 - 1. Operation and Maintenance Data: For each type of gauge to include in operation and maintenance manuals
 - 2. Record actual locations of components and instrumentation.

1.08 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with all applicable requirements of the laws, codes, and ordinances and regulations, authorities having jurisdiction. Obtain necessary approvals from all such authorities.
- B. Qualifications:
 - 1. Contractor: Contractor is responsible for quality of the Work.
 - 2. Manufacturer: A firm experienced in successfully producing work similar to that indicated for this Project with sufficient production capacity to produce required units without causing delay in the Work.
 - 3. An installer trained by the manufacturer in the use of the materials and equipment to be employed in the Work.
- C. Ambient Conditions: Proceed with the Work in accordance with manufacturer's requirements and instructions and any agreements or restrictions of the Pre-Construction Conference, including the following.
- D. Submit two of each type of instrument specified.

1.09 DELIVERY, STORAGE AND HANDLING

- A. Do not install instrumentation when areas are under construction, except for required rough-in, taps, supports and test plugs.
- B. Delivery and Acceptance Requirements: Deliver materials in manufacturer's original packaging with label indicating pertinent information identifying the item.
 - 1. Pertinent Information: Manufacturer's labels identifying product and manufacturer, date of manufacture, lot number, shelf life if applicable, qualified testing and inspecting agency's classification marking applicable to Project; curing time, and mixing instructions for multicomponent materials.
- C. Storage and Handling Requirements: Store materials in accordance with manufacturer's instructions in a protected dry location off ground. Do not open packaging nor remove labels until time of installation.
- D. Store and handle firestopping materials to prevent their deterioration or damage due to moisture, temperature changes, contaminants, or other causes

1.10 EXTRA MATERIALS

- A. Extra Gauge Oil for Inclined Manometers: One bottle.
- B. Extra Pressure Gauges: One of each type and size.

PART 2 PRODUCTS

2.01 THERMOMETERS

- A. Bimetallic-Actuated Thermometers - HVAC and Plumbing Piping
 - 1. Manufacturers:
 - a. Ashcroft Inc.
 - b. Ernst Flow Industries.
 - c. Marsh Bellofram.
 - d. Miljoco Corporation.
 - e. Nanmac Corporation.
 - f. Noshok.

- g. Palmer Wahl Instrumentation Group.
- h. REOTEMP Instrument Corporation.
- i. Tel-Tru Manufacturing Company.
- j. Terice, H. O. Co.
- k. Watts Regulator Co Inc.
- l. Weiss Instruments, Inc.
- m. WIKA Instrument Corporation.
- n. Winters Instruments - U.S
- 2. Source Limitations: Provide lead-free bimetallic-actuated thermometers from a single manufacturer.
- 3. Thermometers used in domestic water systems shall be certified in compliance with NSF 61 and NSF 372 as described in Part 1.
- 4. Standard: ASME B40.200.
- 5. Case: Liquid-filled and sealed type(s); stainless steel with 5 inch (127 mm) nominal diameter.
- 6. Dial: Nonreflective aluminum with permanent scale markings and scales in deg F (deg C).
- 7. Connector Type(s): Union joint, adjustable angle; with ASME B1.1 or ASME B1.20.1 screw threads to fit thermowell.
- 8. Stem: 0.25 or 0.375 inch (6.4 or 9.4 mm) in diameter; stainless steel.
- 9. Window: Safety glass.
- 10. Ring: Stainless steel.
- 11. Element: Bimetal coil.
- 12. Pointer: Dark-colored metal.
- 13. Accuracy: Plus or minus 1 percent of span.
- B. Filled-System Thermometers
 - 1. Direct-Mounted, Plastic-Case, Vapor-Actuated Thermometers:
 - a. Manufacturers:
 - 1) Ashcroft.
 - 2) Miljoco Corporation.
 - 3) REOTEMP Instrument Corporation.
 - b. Standard: ASME B40.200.
 - c. Case: Sealed type, plastic; 4 1/2 inch (114 mm) nominal diameter.
 - d. Element: Bourdon tube or other type of pressure element.
 - e. Movement: Mechanical, with link to pressure element and connection to pointer.
 - f. Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F (deg C).
 - g. Pointer: Dark-colored metal.
 - h. Window: Glass or plastic.
 - i. Ring: Metal or plastic.
 - j. Connector Type(s): Union joint, adjustable, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device rigid, back and rigid, bottom; with ASME B1.1 screw threads.
 - k. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.
 - 1) Design for Air-Duct Installation: With ventilated shroud.
 - 2) Design for Thermowell Installation: Bare stem.
 - l. Accuracy: Plus or minus 1 percent of scale range.
 - 2. Remote-Mounted, Plastic-Case, Vapor-Actuated Thermometers:
 - a. Manufacturers:
 - 1) AMETEK.
 - 2) Ashcroft.

- 3) Miljoco Corporation.
 - 4) REOTEMP Instrument Corporation.
 - 5) Terrice.
 - b. Standard: ASME B40.200.
 - c. Case: Sealed type, plastic; 4 1/2 inch (114 mm) nominal diameter with back flange and holes for panel mounting.
 - d. Element: Bourdon tube or other type of pressure element.
 - e. Movement: Mechanical, with link to pressure element and connection to pointer.
 - f. Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F (deg C).
 - g. Pointer: Dark-colored metal.
 - h. Window: Glass or plastic.
 - i. Ring: Metal or plastic.
 - j. Connector Type(s): Union joint, threaded, back; with ASME B1.1 screw threads.
 - k. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.
 - 1) Design for Air-Duct Installation: With ventilated shroud.
 - 2) Design for Thermowell Installation: Bare stem.
 - l. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.
- C. Liquid-In-Glass Thermometers
- D. Light-Activated Thermometers
- E. Duct-Type, Liquid-In-Glass Thermometers - HVAC Piping Only:
- 1. Manufacturers:
 - a. Miljoco Corporation.
 - b. Terrice.
 - c. Weiss Instruments.
 - 2. Source Limitations: Provide filled-system, lead-free, remote-mounted, metal-case, vapor-actuated thermometers from a single manufacturer.
 - 3. Case: Die-cast aluminum, 7 inches (178 mm) long.
 - 4. Tube: Red or blue reading, mercury or organic filled, with magnifying lens.
 - 5. Tube Background: Satin-faced, nonreflective aluminum with permanently etched scale markings.
 - 6. Window: Glass or plastic.
 - 7. Connector: Adjustable type, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device.
 - 8. Stem: Metal, for installation in mounting bracket and of length to suit installation.
 - 9. Mounting Bracket: Flanged fitting for attachment to duct and made to hold thermometer stem.
 - 10. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

2.02 THERMOWELLS

- A. Thermowells – HVAC and Plumbing Piping:
- 1. Standard: ASME B40.200.
 - 2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
 - 3. Material for Use with Copper Tubing: CNR or CUNI.
 - 4. Material for Use with Steel Piping: CRES.
 - 5. Type: Stepped shank unless straight or tapered shank is indicated.
 - 6. External Threads: NPS 1/2, NPS 3/4, or NPS 1 (DN 15, DN 20, or NPS 25,) ASME B1.20.1 pipe threads.

7. Internal Threads: 1/2, 3/4, and 1 inch (13, 19, and 25 mm), with ASME B1.1 screw threads.
 8. Bore: Diameter required to match thermometer bulb or stem.
 9. Insertion Length: Length required to match thermometer bulb or stem.
 10. Lagging Extension: Include on thermowells for insulated piping and tubing.
 11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.
- B. Heat-Transfer Medium: Mixture of graphite and glycerin.
- C. Manufacturers: Same as manufacturer of thermometer being used.

2.03 PRESSURE GAGES

- A. Direct-Mounted Pressure Gages – Plumbing Piping:
1. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:
 - a. Manufacturers:
 - 1) AMETEK.
 - 2) Ashcroft.
 - 3) Ernst Flow Industries.
 - 4) Flo Fab.
 - 5) Marsh Bellofram.
 - 6) Miljoco Corporation.
 - 7) Noshok.
 - 8) Palmer Wahl Instrumentation Group.
 - 9) REOTEMP Instrument Corporation.
 - 10) Tel-Tru Manufacturing Company.
 - 11) Terrice.
 - 12) Watts.
 - 13) Weiss Instruments.
 - 14) WIKA Instrument Corporation - USA.
 - 15) Winters Instruments - U.S.
 - b. Source Limitations: Provide dial-type, lead-free, direct-mounted, metal-case pressure gauges from single manufacturer.
 - c. Standard: ASME B40.100.
 - d. Case: Indicating type(s); cast aluminum or drawn steel; 4 1/2 inch (114 mm) nominal diameter.
 - e. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
 - f. Pressure Connection: Brass, with NPS 1/4 (DN 8) or NPS 1/2 (DN 15), ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
 - g. Movement: Mechanical, with link to pressure element and connection to pointer.
 - h. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi (kPa).
 - i. Pointer: Dark-colored metal.
 - j. Window: Glass or plastic.
 - k. Ring: Metal Brass.
 - l. Vacuum-Pressure Range: 30-in. Hg of vacuum to 15 psig of pressure (100 kPa of vacuum to 103 kPa of pressure).
 - m. Range for Fluids under Pressure: Two times operating pressure.
 - n. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.
 - o. Plumbing Piping Requirements:
 - 1) Gauges used in domestic water systems shall be certified in compliance with NSF 61 and NSF 372 as described in Part 1.
 - 2) Pressure-Element Assembly: Lead-free Bourdon tube.

- 3) Pressure Connection: Lead-free brass, with NPS 1/4 (DN 8) or NPS 1/2 (DN 15), ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
 2. Direct-Mounted, Plastic-Case, Dial-Type Pressure Gages:
 - a. Manufacturers:
 - 1) AMETEK.
 - 2) Ashcroft.
 - 3) Flo Fab.
 - 4) Marsh Bellofram.
 - 5) Miljoco Corporation.
 - 6) Noshok.
 - 7) Palmer Wahl Instrumentation Group.
 - 8) REOTEMP Instrument Corporation.
 - 9) Tel-Tru Manufacturing Company.
 - 10) Trerice.
 - 11) Weiss Instruments.
 - 12) WIKA Instrument Corporation - USA.
 - 13) Winters Instruments - U.S.
 - b. Standard: ASME B40.100.
 - c. Case: Sealed type; plastic; 4 1/2 inch (114 mm) nominal diameter.
 - d. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
 - e. Pressure Connection: Brass, with NPS 1/4 (DN 8) or NPS 1/2 (DN 15), ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
 - f. Movement: Mechanical, with link to pressure element and connection to pointer.
 - g. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi (kPa).
 - h. Pointer: Dark-colored metal.
 - i. Window: Glass or plastic.
 - j. Vacuum-Pressure Range: 30-in. Hg of vacuum to 15 psig of pressure (100 kPa of vacuum to 103 kPa of pressure).
 - k. Range for Fluids under Pressure: Two times operating pressure.
 - l. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.
- B. Remote-Mounted Pressure Gages
 1. Remote-Mounted, Metal-Case, Dial-Type Pressure Gages:
 - a. Manufacturers:
 - 1) AMETEK.
 - 2) Ashcroft.
 - 3) Ernst Flow Industries.
 - 4) Flo Fab.
 - 5) Marsh Bellofram.
 - 6) Miljoco Corporation.
 - 7) Noshok.
 - 8) Palmer Wahl Instrumentation Group.
 - 9) REOTEMP Instrument Corporation.
 - 10) Tel-Tru Manufacturing Company.
 - 11) Trerice.
 - 12) Watts.
 - 13) Weiss Instruments.
 - 14) WIKA Instrument Corporation - USA.
 - 15) Winters Instruments - U.S.

- b. Source Limitations: Provide dial-type, lead-free, direct-mounted, metal-case pressure gauges from single manufacturer
 - c. Standard: ASME B40.100.
 - d. Case: Liquid-filled type; cast aluminum or drawn steel; 4 1/2 inch (114 mm) nominal diameter with back flange and holes for panel mounting.
 - e. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
 - f. Pressure Connection: Brass, with NPS 1/4 (DN 8) or NPS 1/2 (DN 15), ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
 - g. Movement: Mechanical, with link to pressure element and connection to pointer.
 - h. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi (kPa).
 - i. Pointer: Dark-colored metal.
 - j. Window: Glass or plastic.
 - k. Ring: Metal.
 - l. Vacuum-Pressure Range: 30-in. Hg of vacuum to 15 psig of pressure (100 kPa of vacuum to 103 kPa of pressure).
 - m. Range for Fluids under Pressure: Two times operating pressure.
 - n. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.
 - o. Plumbing Piping Requirements:
 - 1) Gauges used in domestic water systems shall be certified in compliance with NSF 61 and NSF 372 as described in Part 1.
 - 2) Pressure-Element Assembly: Lead-free Bourdon tube.
 - 3) Pressure Connection: Lead-free brass, with NPS 1/4 (DN 8) or NPS 1/2 (DN 15), ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated
2. Remote-Mounted, Plastic-Case, Dial-Type Pressure Gages:
- a. Manufacturers:
 - 1) AMETEK.
 - 2) Ashcroft.
 - 3) Miljoco Corporation.
 - 4) Noshok.
 - 5) Palmer Wahl Instrumentation Group.
 - 6) REOTEMP Instrument Corporation.
 - 7) Tel-Tru Manufacturing Company.
 - 8) Terrice.
 - 9) Weiss Instruments.
 - 10) WIKA Instrument Corporation - USA.
 - 11) Winters Instruments - U.S.
 - b. Standard: ASME B40.100 .
 - c. Case: Sealed type; plastic; 4 1/2 inch (114 mm) nominal diameter with back flange and holes for panel mounting.
 - d. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
 - e. Pressure Connection: Brass, with NPS 1/4 (DN 8) or NPS 1/2 (DN 15), ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
 - f. Movement: Mechanical, with link to pressure element and connection to pointer.
 - g. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi (kPa).
 - h. Pointer: Dark-colored metal.
 - i. Window: Glass or plastic.
 - j. Vacuum-Pressure Range: 30-in. Hg of vacuum to 15 psig of pressure (100 kPa of vacuum to 103 kPa of pressure).
 - k. Range for Fluids under Pressure: Two times operating pressure.

- I. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.04 GAGE ATTACHMENTS

- A. HVAC:
1. Snubbers: ASME B40.100, brass; with NPS 1/4 (DN 8) or NPS 1/2 (DN 15), ASME B1.20.1 pipe threads and porous-metal piston-type surge-dampening device. Include extension for use on insulated piping.
 2. Siphons: Loop-shaped section of brass stainless-steel pipe with NPS 1/4 (DN 8) or NPS 1/2 (DN 15) pipe threads.
 3. Valves: Brass ball, with NPS 1/4 (DN 8) or NPS 1/2 (DN 15), ASME B1.20.1 pipe threads.
- B. Plumbing:
1. Snubbers: ASME B40.100, lead-free brass; with NPS 1/4 (DN 8) or NPS 1/2 (DN 15), ASME B1.20.1 pipe threads and piston-type surge-dampening device. Include extension for use on insulated piping.
 2. Valves: Lead-free brass ball, with NPS 1/4 (DN 8) or NPS 1/2 (DN 15), ASME B1.20.1 pipe threads.

2.05 TEST PLUGS

- A. Manufacturers:
1. IMI Flow Design, I.
 2. Miljoco Corporation.
 3. Nexus Valve, Inc.; Aalberts Hydronic Flow Control.
 4. Peterson Equipment Co.
 5. Terrice.
 6. Watts.
 7. Weiss Instruments.
 8. Weksler Glass Thermometer Corp.
- B. Source Limitations: Provide test-plug2 from single manufacturer.
- C. Description: Test-station fitting made for insertion into piping tee fitting.
- D. Body: Corrosion-resistant brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.
- E. Thread Size: NPS 1/4 (DN 8) or NPS 1/2 (DN 15), ASME B1.20.1 pipe thread.
- F. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F (3450 kPa at 93 deg C).
- G. Core Inserts: EPDM self-sealing rubber.
- H. Plumbing Piping Requirements:
1. Body: Lead-free brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.

2.06 TEST-PLUG KITS

- A. Manufacturers:
1. Flow Design.
 2. Miljoco Corporation.
 3. National Meter.
 4. Peterson Equipment Co.
 5. Sisco Manufacturing Compan.
 6. Terrice.
 7. Watts.
 8. Weiss Instruments.
- B. Source Limitations: Provide test-plug kits from single manufacturer.

- C. Furnish one test kit(s) containing one pressure gage and adaptor, one thermometer(s), and carrying case. Pressure gage, adapter probes, and thermometer sensing elements shall be of diameter to fit test plugs and of length to project into piping.
- D. Low-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch- (25- to 51-mm-) diameter dial and tapered-end sensing element. Dial range shall be at least 25 to 125 deg F (minus 4 to plus 52 deg C).
- E. High-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch- (25- to 51-mm-) diameter dial and tapered-end sensing element. Dial range shall be at least 0 to 220 deg F (minus 18 to plus 104 deg C).
- F. Pressure Gage: Small, Bourdon-tube insertion type with 2- to 3-inch- (51- to 76-mm-) diameter dial and probe. Dial range shall be at least 0 to 200 psig (0 to 1380 kPa).
- G. Carrying Case: Metal or plastic, with formed instrument padding.
- H. Plumbing Piping Requirements:
 - 1. High-Range Thermometer, Lead Free: Small, bimetallic insertion type with 1- to 2-inch-diameter dial and tapered-end sensing element. Dial range is to be at least 0 to 220 deg F.
 - 2. Pressure Gauge, Lead Free: Small, lead-free Bourdon-tube insertion type with 2- to 3 inch- diameter dial and probe. Dial range is to be at least 0 to 200 psig.

2.07 SIGHT FLOW INDICATORS

- A. Manufacturers:
 - 1. Archon Industries.
 - 2. Dwyer Instruments.
 - 3. Emerson Process Management.
 - 4. Ernst Co.
 - 5. Ernst Flow Industries.
 - 6. KOBOLD Instruments.
 - 7. OPW Engineered Systems.
 - 8. Penberthy.
- B. Source Limitations: Provide sight flow indicators from single manufacturer.
- C. Description: Piping inline-installation device for visual verification of flow.
- D. Construction: Bronze or stainless-steel body, with sight glass and ball, flapper, or paddle wheel indicator, and threaded or flanged ends.
- E. Minimum Pressure Rating: 150 psig (1034 kPa).
- F. Minimum Temperature Rating: 200 deg F (93 deg C).
- G. End Connections for NPS 2 (DN 50) and Smaller: Threaded.
- H. End Connections for NPS 2-1/2 (DN 65) and Larger: Flanged.
- I. Plumbing Piping Requirements:
 - 1. Construction: Lead-free bronze or stainless-steel body, with sight glass and ball, flapper, or paddle wheel indicator, and threaded or flanged ends.

2.08 FLOWMETERS

- A. Orifice Flowmeters:
 - 1. Manufacturers:
 - a. ABB
 - b. Bell & Gossett
 - c. Meriam Process Technologies.
 - d. Preso Meters.
 - e. S. A. Armstrong Limited.

2. Description: Flowmeter with sensor, hoses or tubing, fittings, valves, indicator, and conversion chart.
 3. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.
 4. Sensor: Wafer-orifice-type, calibrated, flow-measuring element; for installation between pipe flanges.
 - a. Design: Differential-pressure-type measurement for gas.
 - b. Construction: Cast-iron body, brass valves with integral check valves and caps, and calibrated nameplate.
 - c. Minimum Pressure Rating: 300 psig (2070 kPa).
 - d. Minimum Temperature Rating: 250 deg F (121 deg C).
 5. Permanent Indicators: Meter suitable for wall or bracket mounting, calibrated for connected sensor and having 6-inch- (152-mm-) diameter, or equivalent, dial with fittings and copper tubing for connecting to sensor.
 - a. Scale: Gallons per minute (Liters per second).
 - b. Accuracy: Plus or minus 1 percent between 20 and 80 percent of scale range.
 6. Portable Indicators: Hand-held, differential-pressure type, calibrated for connected sensor and having two 12-foot (3.7-m) hoses, with carrying case.
 - a. Scale: Gallons per minute (Liters per second).
 - b. Accuracy: Plus or minus 2 percent between 20 and 80 percent of scale range.
 7. Display: Visual instantaneous rate of flow, with register to indicate total volume in gallons (liters).
 8. Conversion Chart: Flow rate data compatible with sensor and indicator.
 9. Operating Instructions: Include complete instructions with each flowmeter.
- B. Pitot-Tube Flowmeters:
1. Manufacturers:
 - a. ABB.
 - b. Emerson Process Management
 - c. Meriam Process Technologies.
 - d. Preso Meters.
 - e. Taco.
 - f. Veris Industries.
 2. Description: Flowmeter with sensor and indicator.
 3. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.
 4. Sensor: Insertion type; for inserting probe into piping and measuring flow directly in gallons per minute (liters per second).
 - a. Design: Differential-pressure-type measurement for oil.
 - b. Construction: Stainless-steel probe of length to span inside of pipe, with integral transmitter and direct-reading scale.
 - c. Minimum Pressure Rating: 150 psig (1035 kPa).
 - d. Minimum Temperature Rating: 250 deg F (121 deg C).
 - e. Indicator: Hand-held meter; either an integral part of sensor or a separate meter.
 5. Integral Transformer: For low-voltage power connection.
 6. Accuracy: Plus or minus 3 percent.
 7. Display: Visual instantaneous rate of flow, with register to indicate total volume in gallons (liters).
 8. Operating Instructions: Include complete instructions with each flowmeter.
- C. Turbine Flowmeters:
1. Manufacturers:
 - a. ABB.

- b. Data Industrial Corp.
- c. EMCO Flow Systems.
- d. ERDCO Engineering Corp.
- e. Hoffer Flow Controls.
- f. Liquid Controls.
- g. McCrometer.
- h. Midwest Instruments & Controls Corp.
- i. ONICON Incorporated.
- j. SeaMetrics.
- k. Sponsler.
- 2. Victaulic Company.
- 3. Description: Flowmeter with sensor and indicator.
- 4. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.
- 5. Sensor: Impeller turbine; for inserting into pipe fitting or for installing in piping and measuring flow directly in gallons per minute (liters per second).
 - a. Design: Device or pipe fitting with inline turbine and integral direct-reading scale for gas.
 - b. Construction: Bronze or stainless-steel body, with plastic turbine or impeller.
 - c. Minimum Pressure Rating: 150 psig (1035 kPa).
 - d. Minimum Temperature Rating: 180 deg F (82 deg C).
- 6. Indicator: Hand-held meter; either an integral part of sensor or a separate meter.
- 7. Accuracy: Plus or minus 1-1/2 percent.
- 8. Display: Visual instantaneous rate of flow, with register to indicate total volume in gallons (liters).
- 9. Operating Instructions: Include complete instructions with each flowmeter.
- D. Venturi Flowmeters:
 - 1. Manufacturers:
 - a. ABB.
 - b. Gerand Engineering Co.
 - c. Hyspan Precision Products.
 - d. Preso Meters; a division of Racine Federated.
 - e. S. A. Armstrong Limited.
 - 2. Description: Flowmeter with calibrated flow-measuring element, hoses or tubing, fittings, valves, indicator, and conversion chart.
 - 3. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.
 - 4. Sensor: Venturi-type, calibrated, flow-measuring element; for installation in piping.
 - a. Design: Differential-pressure-type measurement for gas.
 - b. Construction: Bronze, brass, or factory-primed steel, with brass fittings and attached tag with flow conversion data.
 - c. Minimum Pressure Rating: 250 psig (1725 kPa).
 - d. Minimum Temperature Rating: 250 deg F (121 deg C).
 - e. End Connections for NPS 2 (DN 50) and Smaller: Threaded.
 - f. End Connections for NPS 2-1/2 (DN 65) and Larger: Flanged or welded.
 - g. Flow Range: Flow-measuring element and flowmeter shall cover operating range of equipment or system served.
 - 5. Permanent Indicators: Meter suitable for wall or bracket mounting, calibrated for connected flowmeter element, and having 6-inch- (152-mm-) diameter, or equivalent, dial with fittings and copper tubing for connecting to flowmeter element.
 - a. Scale: Gallons per minute (Liters per second).
 - b. Accuracy: Plus or minus 1 percent between 20 and 80 percent of scale range.

6. Portable Indicators: Hand-held, differential-pressure type, calibrated for connected flowmeter element and having two 12-foot (3.7-m) hoses, with carrying case.
 - a. Scale: Gallons per minute (Liters per second).
 - b. Accuracy: Plus or minus 2 percent between 20 and 80 percent of scale range.
 7. Display: Visual instantaneous rate of flow, with register to indicate total volume in gallons (liters).
 8. Conversion Chart: Flow rate data compatible with sensor.
 9. Operating Instructions: Include complete instructions with each flowmeter.
- E. Vortex-Shedding Flowmeters:
1. Manufacturers:
 - a. ABB.
 - b. Eastech Flow Controls.
 - c. EMCO Flow Systems.
 - d. Emerson Process Management.
 - e. Endress+Hauser.
 - f. ISTECH Corporation.
 2. Description: Flowmeter with sensor and indicator.
 3. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.
 4. Sensor: Inline type; for installing between pipe flanges and measuring flow directly in gallons per minute (liters per second).
 - a. Design: Flow obstruction device, vortex-measurement type for gas, steam, and liquids.
 - b. Construction: Stainless-steel body, with integral transmitter and direct-reading scale.
 - c. Minimum Pressure Rating: 1000 psig (6900 kPa).
 - d. Minimum Temperature Rating: 500 deg F (260 deg C).
 - e. Integral Transformer: For low-voltage power operation.
 5. Indicator: Hand-held meter; either an integral part of sensor or a separate meter.
 6. Accuracy: Plus or minus 0.25 percent for liquids and 0.75 percent for gases.
 7. Display: Visual instantaneous rate of flow, with register to indicate total volume in gallons (liters).
 8. Operating Instructions: Include complete instructions with each flowmeter.

2.09 THERMAL-ENERGY METERS

- A. Impeller-Turbine, Thermal-Energy Meters:
1. Manufacturers:
 - a. Data Industrial Corp.
 - b. Hoffer Flow Controls.
 - c. ISTECH Corporation.
 - d. ONICON Incorporated.
 2. Description: System with strainer, flow sensor, temperature sensors, transmitter, indicator, and connecting wiring.
 3. Flow Sensor: Impeller turbine with corrosion-resistant-metal body and transmitter; for installing in piping.
 - a. Design: Total thermal-energy measurement.
 - b. Minimum Pressure Rating: 150 psig (1035 kPa).
 - c. Minimum Temperature Range: 40 to 250 deg F (5 to 121 deg C).
 4. Temperature Sensors: Insertion-type transducer.
 5. Indicator: Solid-state, integrating-type meter with integral battery pack; for wall mounting.
 - a. Data Output: Six-digit electromechanical counter with readout in kilowatts per hour or British thermal units (joules).
 - b. Battery Pack: Five-year lithium battery.

6. Accuracy: Plus or minus 1 percent.
 7. Display: Visually indicates total fluid volume in gallons (liters) and thermal-energy flow in kilowatts per hour or British thermal units (joules).
 8. Strainer: Full size of main line piping.
 9. Operating Instructions: Include complete instructions with each thermal-energy meter system.
- B. Ultrasonic, Thermal-Energy Meters:
1. Manufacturers:
 - a. EMCO Flow Systems.
 - b. Siemens Energy & Automation.
 2. Description: Meter with flow sensor, temperature sensors, transmitter, indicator, and connecting wiring.
 3. Flow Sensor: Transit-time ultrasonic type with transmitter.
 4. Temperature Sensors: Insertion-type or strap-on transducer.
 5. Indicator: Solid-state, integrating-type meter with integral battery pack.
 - a. Data Output: Six-digit electromechanical counter with readout in kilowatts per hour or British thermal units (joules).
 - b. Battery Pack: Five-year lithium battery.
 6. Accuracy: Plus or minus 1 percent.
 7. Display: Visually indicates total fluid volume in gallons (liters) and thermal-energy flow in kilowatts per hour or British thermal units (joules).
 8. Operating Instructions: Include complete instructions with each thermal-energy meter system.
 9. Strainer: Full size of main line piping.

2.10 INSERTION-TURBINE, THERMAL-ENERGY METER SYSTEMS

- A. Manufacturers:
1. Data Industrial Corp.
 2. ONICON Incorporated.
 3. Thermo Measurement Ltd.
- B. Description: Flow sensor, strainer, two temperature sensors, transmitter, meter, and connecting wiring.
- C. Flow Sensor: Insertion-type turbine or paddle-wheel element with corrosion-resistant-metal body and transmitter.
1. Pressure Rating: 125 psig (860 kPa).
 2. Temperature Range: 40 to 250 deg F (5 to 121 deg C).
- D. Meter: Solid-state integrating type with integral battery pack.
1. Data Output: Six-digit electromechanical counter with readout in kilowatts per hour or British thermal units (joules).
 2. Accuracy: Plus or minus 1 percent.
 3. Battery Pack: Five-year lithium battery.

PART 3 EXECUTION

3.01 APPLICATION

- A. Thermometers, Lead Free for Plumbing Systems:
1. Thermometers at inlet and outlet of each domestic water heater are to be the following:
 - a. Liquid-filled Sealed, bimetallic-actuated type.
 - b. Direct or remote-mounted, metal-case, vapor-actuated type.
 - c. Metal case, industrial-style, liquid-in-glass type.
 - d. Test plug with EPDM self-sealing rubber inserts.

2. Thermometers at inlets and outlets of each domestic water heat exchanger are to be the following:
 - a. Liquid-filled Sealed, bimetallic-actuated type.
 - b. Direct or remote-mounted, metal-case, vapor-actuated type.
 - c. Metal case, industrial-style, liquid-in-glass type.
 - d. Test plug with EPDM self-sealing rubber inserts.
 3. Thermometers at inlet and outlet of each domestic hot-water storage tank are to be the following:
 - a. Liquid-filled Sealed, bimetallic-actuated type.
 - b. Direct or remote-mounted, metal-case, vapor-actuated type.
 - c. Metal case, industrial-style, liquid-in-glass type.
 - d. Test plug with EPDM self-sealing rubber inserts.
 4. Thermometers at inlet and outlet of each domestic hot-water master thermostatic mixing valve are to be the following:
 - a. Liquid-filled Sealed, bimetallic-actuated type.
 - b. Direct or remote-mounted, metal-case, vapor-actuated type.
 - c. Metal case, industrial-style, liquid-in-glass type.
 - d. Test plug with EPDM self-sealing rubber inserts.
 5. Thermometers at inlet and outlet of each domestic water booster pump are to be the following:
 - a. Liquid-filled Sealed, bimetallic-actuated type.
 - b. Direct or remote-mounted, metal-case, vapor-actuated type.
 - c. Metal case, industrial-style, liquid-in-glass type.
 - d. Test plug with EPDM self-sealing rubber inserts.
 6. Thermometers at inlet and outlet of each domestic hot water return pump are to be the following:
 - a. Liquid-filled Sealed, bimetallic-actuated type.
 - b. Direct or remote-mounted, metal-case, vapor-actuated type.
 - c. Metal case, industrial-style, liquid-in-glass type.
 - d. Test plug with EPDM self-sealing rubber inserts.
 7. Thermometers at inlet and outlet of each remote domestic water chiller are to be the following:
 - a. Liquid-filled Sealed, bimetallic-actuated type.
 - b. Direct or remote-mounted, metal-case, vapor-actuated type.
 - c. Metal case, industrial-style, liquid-in-glass type.
 - d. Test plug with EPDM self-sealing rubber inserts.
 8. Thermometer stems are to be of length to match thermowell insertion length.
- B.
1. Scale Range for Domestic Cold-Water Piping:
 - a. 0 to 150 deg F.
 2. Scale Range for Domestic Hot-Water Piping:
 - a. 0 to 250 deg F.
 3. Scale Range for Domestic Cooled-Water Piping:
 - a. 0 to 100 deg F.
- C. Thermometers for HVAC Systems
1. Inlet and outlet of each hydronic zone.
 2. Inlet and outlet of each hydronic boiler.
 3. Two inlets and two outlets of each chiller.
 4. Two inlets and two outlets of each hydronic heat exchanger.
 5. Inlet and outlet of each thermal-storage tank.
 6. Outside-, return-, supply-, and mixed-air ducts.

7. Thermometer Schedule

- a. Thermometers at inlet and outlet of each hydronic zone shall be one of the following:
 - 1) Industrial-style, liquid-in-glass type.
 - 2) Liquid-filled, bimetallic-actuated type.
 - 3) Direct-mounted, metal-case, vapor-actuated type.
 - 4) Direct-mounted, light-activated type.
 - 5) Test plug with EPDM self-sealing rubber inserts.
- b. Thermometers at inlet and outlet of each hydronic boiler shall be one of the following:
 - 1) Industrial-style, liquid-in-glass type.
 - 2) Liquid-filled, bimetallic-actuated type.
 - 3) Direct-mounted, metal-case, vapor-actuated type.
 - 4) Direct-mounted, light-activated type.
 - 5) Test plug with EPDM self-sealing rubber inserts.
- c. Thermometers at inlets and outlets of each chiller shall be one of the following:
 - 1) Industrial-style, liquid-in-glass type.
 - 2) Liquid-filled, bimetallic-actuated type.
 - 3) Direct-mounted, metal-case, vapor-actuated type.
 - 4) Direct-mounted, light-activated type.
 - 5) Test plug with EPDM self-sealing rubber inserts.
- d. Thermometers at inlet and outlet of each hydronic coil in air-handling units and built-up central systems shall be one of the following:
 - 1) Industrial-style, liquid-in-glass type.
 - 2) Liquid-filled, bimetallic-actuated type.
 - 3) Direct-mounted, metal-case, vapor-actuated type.
 - 4) Direct-mounted, light-activated type.
 - 5) Test plug with EPDM self-sealing rubber inserts.
- e. Thermometers at inlets and outlets of each hydronic heat exchanger shall be one of the following:
 - 1) Industrial-style, liquid-in-glass type.
 - 2) Liquid-filled, bimetallic-actuated type.
 - 3) Direct-mounted, metal-case, vapor-actuated type.
 - 4) Direct-mounted, light-activated type.
 - 5) Test plug with EPDM self-sealing rubber inserts.
- f. Thermometers at inlet and outlet of each hydronic heat-recovery unit shall be one of the following:
 - 1) Industrial-style, liquid-in-glass type.
 - 2) Liquid-filled, bimetallic-actuated type.
 - 3) Direct-mounted, metal-case, vapor-actuated type.
 - 4) Direct-mounted, light-activated type.
 - 5) Test plug with EPDM self-sealing rubber inserts.
- g. Thermometers at inlet and outlet of each thermal-storage tank shall be one of the following:
 - 1) Industrial -style, liquid-in-glass type.
 - 2) Liquid-filled, bimetallic-actuated type.
 - 3) Direct-mounted, metal-case, vapor-actuated type.
 - 4) Direct-mounted, light-activated type.
 - 5) Test plug with EPDM self-sealing rubber inserts.
- h. Thermometers at outside-, return-, supply-, and mixed-air ducts shall be one of the following:
 - 1) Industrial-style, liquid-in-glass type.
 - 2) Liquid-filled, bimetallic-actuated type.
 - 3) Direct-mounted, metal-case, vapor-actuated type.

- 4) Direct-mounted, light-activated type.
 - i. Thermometers at suction and discharge of each pump shall be the following:
 - 1) Dry-case-type, bimetallic-actuated dial thermometers at suction and discharge of each pump.
- 8. Thermometer Scale-Range Schedule for HVAC Systems
 - a. Scale Range for Chilled-Water Piping: minus 40 to plus 160 deg F (minus 40 to plus 100 deg C).
 - b. Scale Range for Condenser-Water Piping: 0 to 100 deg F (minus 20 to plus 50 deg C).
 - c. Scale Range for Heating, Hot-Water Piping: 0 to 250 deg F (0 to 150 deg C).
 - d. Scale Range for Steam and Steam-Condensate Piping: 0 to 250 deg F (0 to 150 deg C).
 - e. Scale Range for Air Ducts: minus 40 to plus 110 deg F (minus 40 to plus 45 deg C).
- D. Pressure Gages Application for Plumbing Systems:
 - 1. Install pressure gages in the following locations:
 - a. Plumbing Systems:
 - 1) Building water service entrance into building.
 - 2) Inlet and outlet of each pressure-reducing valve.
 - 3) Suction and discharge of each domestic water pump.
 - 2. Pressure-Gage Schedule
 - a. Pressure gages at discharge of each water service into building shall be one of the following:
 - 1) Liquid-filled, direct-mounted, metal case.
 - 2) Sealed, direct-mounted, plastic case.
 - 3) Test plug with EPDM self-sealing rubber inserts.
 - b. Pressure gages at inlet and outlet of each water pressure-reducing valve shall be one of the following:
 - 1) Liquid-filled, direct-mounted, metal case.
 - 2) Sealed, direct-mounted, plastic case.
 - 3) Test plug with EPDM self-sealing rubber inserts.
 - c. Pressure gages at suction and discharge of each domestic water pump shall be one of the following:
 - 1) Liquid-filled, direct-mounted, metal case.
 - 2) Sealed, direct-mounted, plastic case.
 - 3) Test plug with EPDM self-sealing rubber inserts.
 - 3. Pressure Gage Scale Range:
 - a. Scale Range for Water Service Piping:
 - 1) 0 to 160 psi [0 to 160 psi] [0 to 160 psi and 0 to 1100 kPa].
 - b. Scale Range for Domestic Water Piping:
 - 1) 0 to 100 psi.
 - 2) 0 to 300 psi.
- E. Pressure Gages Application for HVAC Systems:
 - 1. Install pressure gages in the following locations:
 - a. HVAC Systems:
 - 1) Inlet and outlet of each pressure-reducing valve.
 - 2) Inlet and outlet of each chiller chilled-water and condenser-water connection.
 - 3) Suction and discharge of each pump.
 - 2. Pressure Gage Schedule:
 - a. Pressure gages at discharge of each hydronic pressure-reducing valve shall be one of the following:
 - 1) Liquid-filled, direct-mounted, metal case.

- 2) Sealed, direct-mounted, plastic case.
 - 3) Test plug with EPDM self-sealing rubber inserts.
 - b. Pressure gages at inlet and outlet of each chiller chilled-water and condenser-water connection shall be one of the following:
 - 1) Liquid-filled, direct-mounted, metal case.
 - 2) Sealed, direct-mounted, plastic case.
 - 3) Test plug with EPDM self-sealing rubber inserts.
 - c. Pressure gages at suction and discharge of each HVAC pump shall be one of the following:
 - 1) Liquid-filled, direct-mounted, metal case.
 - 2) Sealed, direct-mounted, plastic case.
 - 3) Test plug with EPDM self-sealing rubber inserts.
3. Pressure Gauge Scale-Range Schedule
 - a. Scale Range for Chilled-Water Piping: 30 in Hg to 15 psi (minus 100 to 0 kPa).
 - b. Scale Range for Condenser-Water Piping: 30 in Hg to 15 psi (minus 100 to 0 kPa).
 - c. Scale Range for Heating, Hot-Water Piping: 30 in Hg to 15 psi (minus 100 to 0 kPa).
 - d. Scale Range for Steam Piping: 30 in Hg to 15 psi (minus 100 to 0 kPa).
 - e. Scale Range for Steam Piping (steam less than 15 psig): 0 to 30 psi (0 to 240 kPa).
 - f. Scale Range for Steam Piping (steam 15 psig to 75 psig): 0 to 100 psi (0 to 600 kPa).
 - g. Scale Range for Steam Piping (steam 75 psig to 100 psig): 0 to 160 psi (0 to 1100 kPa).
 - h. Scale Range for Steam Piping: 0 to 200 psi (0 to 1400 kPa).
- F. Flow Meters
 1. Flow Meter Schedule
 - a. Flowmeters for Chilled-Water Piping: Orifice type.
 - b. Flowmeters for Condenser-Water Piping: Orifice type.
 - c. Flowmeters for Heating, Hot-Water Piping: Orifice type.
 - d. Flowmeters for Steam and Steam-Condensate Piping: Venturi type.
- G. Thermal-Energy Meters
 1. Thermal-Energy Meter Schedule
 - a. Thermal-Energy Meters for Chilled-Water Piping: Impeller-turbine type.
 - b. Thermal-Energy Meters for Condenser-Water Piping: Impeller-turbine type.
 - c. Thermal-Energy Meters for Heating, Hot-Water Piping: Impeller-turbine type.
 - d. Thermal-Energy Meters for Steam and Steam-Condensate Piping: Impeller-turbine type.

3.02 INSTALLATION

- A. General
 1. Install permanent indicators on walls or brackets in accessible and readable positions.
 2. Install connection fittings in accessible locations for attachment to portable indicators.
 3. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.
- B. Thermometers
 1. Thermometer stems shall be of length to match thermowell insertion length.
 2. Install thermometers in hydronic piping serving a multiple-coil array as indicated on drawing details. Provide liquid filled, high-range thermometers on hot water heating coils; provide liquid filled, low-range thermometers on cooling coils.
 3. Install thermometers in the following locations for Plumbing Systems:
 - a. Inlet and outlet of each water heater.
 - b. Inlets and outlets of each domestic water heat exchanger.
 - c. Inlet and outlet of each domestic hot-water storage tank.

- d. Inlet and outlet of each remote domestic water chiller.
 - e. Hot water returns main to each domestic water heating system.
 - f. Cold water and hot water inlet to each master mixing valve.
 - g. Tempered (mixed) water outlet of each master mixing valve.
- C. Thermowells
- 1. Install thermowells with socket extending one-third of pipe diameter a minimum of 2 inches (51 mm) into fluid and in vertical position in piping tees.
 - 2. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
 - 3. Install thermowells with extension on insulated piping.
 - 4. Fill thermowells with heat-transfer medium.
 - 5. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
 - 6. Inlet and outlet of each hydronic coil in air-handling units.
 - 7. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing and support tubing to prevent kinks. Use minimum tubing length.
- D. Pressure Gauges:
- 1. Install remote-mounted pressure gauges on panel.
 - 2. Install valve and snubber in piping for each pressure gauge for fluids.
 - 3. Install test plugs in piping tees.
 - 4. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
 - 5. Install valve and syphon fitting in piping for each pressure gage for steam.
 - 6. Install Pressure Gauges in the following locations for Plumbing Systems:
 - 7. Building water service entrance into building.
 - a. Inlet and outlet of each pressure-reducing valve.
 - b. Suction and discharge of each domestic water pump.
 - c. Inlets and outlet of each master mixing valve.
- E. Thermometers, pressure gages and test plugs of the indicated type shall be installed as indicated and in the following locations for HVAC Systems:

<u>THERMOMETER, PRESSURE GAGE AND TEST PLUG SCHEDULE</u>			
<u>Location</u>	<u>Thermometer Type and Scale Range</u>	<u>Pressure Gage</u>	<u>Test Plug</u>
Hydronic Zone Inlet and Outlet	Liquid - High	X	
Hydronic Boiler Inlet and Outlet	Liquid - High	X	
Chiller: Chilled Water and Condenser Water Inlets and Outlets	Liquid - Low	X	
Hydroinc Coils in Air Handling Units, Inlet and Outlet (Water side)			X
Heating Hydronic Heat Exchangers, Inlets and Outlets	Liquid - High	X	
Cooling Hydronic Heat Exchangers, Inlets and Outlets	Liquid - Low	X	
Outdoor air intake, Return Air and Supply Air Ducts at each Air Handling Unit	Bimetallic -Minus 10 degrees (F) to 125 degrees (F)		

<u>THERMOMETER, PRESSURE GAGE AND TEST PLUG SCHEDULE</u>			
Hydronic Pumps, Suction and Discharge		X	
Pressure Reducing Valve Inlet and Outlet		X	
Hydronic Duct Heating Coil, VAV Box Coil, Fancoils, Heat Pumps, Inlet and Outlet (Water side)			X

F. Sight Flow Indicators:

1. Install flow indicators in piping systems in accessible positions for easy viewing.
2. Install Sight Flow Indicator at chilled water piping connection to medial equipment.

G. Flow Meters:

1. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters according to manufacturer's written instructions.
2. Install flowmeter elements in accessible positions in piping systems.
3. Install wafer-orifice flowmeter elements between pipe flanges.
4. Install differential-pressure-type flowmeter elements, with at least minimum straight lengths of pipe, upstream and downstream from element according to manufacturer's written instructions.
5. Install differential-pressure-type flowmeter elements with at least minimum straight lengths of pipe upstream and downstream from element as prescribed by manufacturer's written instructions.
6. Install flowmeters at discharge of hydronic system pumps and at inlet of hydronic air coils.
7. Connect flowmeter-system elements to meters.
8. Connect flowmeter transmitters to meters.

H. Thermal Energy Meters

1. Assemble components and install thermal-energy meters.
2. Mount thermal-energy meters on wall if accessible; if not, provide brackets to support meters.
3. Connect thermal-energy meter transmitters to meters.

3.03 CONNECTIONS

A. Piping Connections

1. Install meters and gauges adjacent to machines and equipment to allow space for service and maintenance of meters, gauges, machines, and equipment.

3.04 ADJUSTING

- A. After installation, calibrate meters according to manufacturer's written instructions.
- B. Adjust faces of meters and gages to proper angle for best visibility.

3.05 TESTING

- A. Prior to testing thermometers and gauges, test air vent points to insure all air has been vented.
- B. Test thermometers and pressure gauges for accurate indication with known calibrated master gauge and thermometer.

END OF SECTION

**SECTION 20 05 29
HANGERS AND SUPPORTS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Metal Pipe Hangers and Supports
 - 1. Manufacturers
 - 2. Carbon-Steel Pipe Hangers and Supports
 - 3. Stainless-Steel Pipe Hangers and Supports
 - 4. Copper Pipe Hangers
- B. Trapeze Pipe Hangers
 - 1. Description
- C. Fiberglass Pipe Hangers
 - 1. Manufacturers
 - 2. Clevis-Type, Fiberglass Pipe Hangers
 - 3. Strap-Type, Fiberglass Pipe Hangers
- D. Metal Framing Systems
 - 1. Manufacturers
 - 2. Description
 - 3. Standard: MFMA-4
 - 4. Channels
 - 5. Channel Nuts
 - 6. Hanger Rods
 - 7. Metallic Coating
 - 8. Paint Coating
- E. Fiberglass Strut Systems
 - 1. Manufacturers
 - 2. Description
 - 3. Standard
 - 4. Channels
 - 5. Channel Width
 - 6. Fittings and Accessories
 - 7. Fitting and Accessory Materials
 - 8. Rated Strength
 - 9. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping
- F. Thermal-Hanger Shield Inserts
 - 1. Manufacturers
 - 2. Insulation-Insert Material for Cold Piping
 - 3. Insulation-Insert Material for Hot Piping
 - 4. For Trapeze or Clamped Systems
 - 5. For Clevis or Band Hangers
 - 6. Insert Length
- G. Fastener Systems
 - 1. Powder-Actuated Fasteners
 - 2. Mechanical-Expansion Anchors
 - 3. Outdoor Applications
- H. Pipe Stands
 - 1. General Requirements for Pipe Stands

2. Compact Pipe Stand
 3. Base
 4. Hardware
 5. Accessories
 6. Low-Profile, Single-Base, Single-Pipe Stand
 7. Description
 8. Base
 9. Accessories: Protection pads.
 10. High-Profile, Single-Base, Single-Pipe Stand
 11. Description
 12. Base
 13. High-Profile, Multiple-Pipe Stand
 14. Curb-Mounted-Type Pipe Stands
 15. Pipe Stands, General: Shop or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping, ductwork and equipment.
- I. Pipe Positioning Systems
1. Manufacturers
 2. Description
- J. Equipment Supports
1. Description
- K. Miscellaneous Materials
1. Aluminum
 2. Carbon Steel
 3. Structural Steel
 4. Stainless Steel
 5. Grout
- L. Roof Curbs for Piping and Equipment Support
1. Wood blocking or other materials placed directly on roof to support piping or equipment is not acceptable
 2. Roof Curbs
 3. Size
 4. Loads
 5. Material
 6. Construction

1.02 RELATED REQUIREMENTS

- A. Section 05 50 00 - Metal Fabrications: Materials and requirements for fabricated metal supports.
- B. Section 20 05 00 - Common Mechanical Work Results
- C. Section 20 05 48 - Vibration and Seismic Controls
- D. 20 05 00 - Common Mechanical Work Results Section 21 05 00 - Common Work Results For Fire-Protection for hangers and supports for use on the fire protection systems.

1.03 REFERENCE STANDARDS

- A. ASME B31.9 - Building Services Piping; 2020.
- B. {RSTEMP#undefined}
- C. ASTM A304 - Standard Specification for Carbon and Alloy Steel Bars Subject to End-Quench Hardenability Requirements; 2020.

- D. ASTM A780/A780M - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings; 2020.
- E. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength; 2023.
- F. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2021.
- G. ASTM C533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation; 2017 (Reapproved 2023).
- H. ASTM C591 - Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation; 2022.
- I. ASTM C1107/C1107M - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink); 2020.
- J. ASTM D635 - Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position; 2022.
- K. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2024.
- L. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2025.
- M. IAPMO PS 42 - Pipe Alignment and Secondary Support Systems; 2012.
- N. MFMA-3 - Metal Framing Systems; Approved.
- O. MFMA-4 - Metal Framing Standards Publication; 2004.
- P. MFMA-102 - Emergency Procurement in Response to National State of Disaster; 2020.
- Q. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2018, with Amendment (2019).
- R. MSS SP-69 - Pipe Hangers And Supports - Selection And Application; Approved Edition.
- S. MSS SP-89 - Pipe Hangers and Supports - Fabrication and Installation Practices; 2003.
- T. SSPC-PA 1 - Shop, Field, and Maintenance Coating of Metals; 2024.

1.04 DEFINITIONS

- A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc
- B. Firestopping (Through-Penetration Protection System): Sealing or stuffing material or assembly placed in spaces between and penetrations through building materials to arrest movement of fire, smoke, heat, and hot gases through fire rated construction.
- C. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.05 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Division 01 Section "Quality Requirements," to design trapeze pipe hangers and equipment supports.
- B. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
 - 1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
 - 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
 - 3. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction

C. Hangers and Supports

1. Hangers and Supports shall be designed by a professional structural engineer in the State of Alaska who is hired by the Contractor to meet the anchorage requirements of the Building Code. Design shall be submitted with signed calculations provided for review by the owner and the building's structural engineer prior to installation of inserts or pouring of concrete. All responsibility for design and installation of supports and structural modifications necessary to accommodate the supports is borne by the contractor. The point loads at all locations where the supports attach to steel or concrete structure shall be identified in a combined submittal managed by the General Contractor to demonstrate all super imposed loads from all suspended elements so that the building structural engineer can review if the structure is adequate for the loads within the design allowance. Total load tributary to a girder not to exceed values in the structural loading plans. In the event that the building structure cannot take the stated point load, the contractor is responsible at no cost to the project for redesign of the support system to spread the load.
2. Properly support all material, equipment and apparatus. Provide minimum safety factor per Building Code requirements, based on ultimate tensile or compressive strength, as applicable, or material used. Turnbuckles and rod couplings capacity not less than attached rod. Calculate with equipment and piping full of water.
3. Where anchorage requires attachment to structural steel, a design shall be submitted for review by the structural engineer.
 - a. Structural steel shall not be loaded eccentrically.
 - b. The anchorage design engineer shall propose the stiffener or other structural stiffening necessary to accommodate the hanger.
 - c. Where the size of the proposed anchorage requires a transfer plate, this plate shall be designed by the anchorage design engineer.
 - d. If the structural engineer in any way indicates that proposed design would exceed the local capacity of the structure, the contractor bears full responsibility for redesign of the proposed support at no cost to the project.
4. In new slabs, inserts shall be used whenever possible. Expansion anchors will be allowed on a case-by-case in the event that an insert is mislocated. The area must be ferro-scanned with results submitted for review by the structural engineer for approval of drilling.
5. Installation of anchors after the concrete is poured can be considered for use throughout in new slabs with the structural engineer's review if a current ICC report is available for the proposed anchor and the proposed specific use.
6. Existing slabs for the building are tapered and nominally 3.0" (min.) thick hard aggregate concrete. Thickness may vary depending on location in the building, contractor to verify slab thickness prior to installation. Expansion anchors shall penetrate no more than that permitted by the relevant product number of 2" maximum, and be laced with the structural engineer's approval. Existing slab is assumed to be 3000 psi capacity. Where the imposition of a hanger support requires not only structural strengthening, but also causes the owner to question of the building's capacity to accommodate the load, the contractor shall bear the cost of time and materials for the owner to review and analyze the effects of the imposed loading.

1.06 SUBMITTALS

A. Action Submittals

1. Product Data: For each type of product indicated.
2. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following; include Product Data for components:
 - a. Trapeze pipe hangers.
 - b. Metal framing systems.
 - c. Pipe stands.
 - d. Equipment supports.

3. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - a. Detail fabrication and assembly of trapeze hangers.
 - b. Design Calculations: Calculate requirements for designing trapeze hangers.
4. Fiberglass Channel (Strut) Framing Systems: Include requirements for strength derating according to ambient temperature.
5. Shop Drawings: Include details for fabricated hangers and supports where materials or methods other than those indicated are proposed for substitution.
 - a. Application of protective inserts, saddles, and shields at pipe hangers for each type of insulation and hanger.
6. Derating Calculations for Fiberglass Channel (Strut) Framing Systems: Indicate load ratings adjusted for applicable service conditions.
7. Evaluation Reports: For products specified as requiring evaluation and recognition by ICC Evaluation Service, LLC (ICC-ES), provide current ICC-ES evaluation reports upon request.
8. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
9. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.
10. Required Embodied Carbon Submittals: All products which satisfy one of the following criteria will require an Embodied Carbon Submittal:
 - a. The product is a 'Major' piece of equipment
 - b. The product contains refrigerant
 - c. The cost of a group of products serving a given function constitutes 5% or greater of the sub-contractor's budget, excluding labor.
11. Embodied Carbon Submittals
 - a. Order of Preferred Submittals: For products which require an embodied carbon submittal (described above), one of the following must be provided. The submittal must be that with the highest preference available. The order preference, from highest to lowest is:
 - 1) Product Specific, Facility Specific EPD
 - 2) Product Specific EPD
 - 3) Industry Average EPD
 - 4) TM65 Manufacturer Form with Mid-Level Calculation data
 - 5) TM65 Manufacturer Form with Basic Calculation data
- B. Informational Submittals
 1. Welding certificates.
- C. Operation and Maintenance Materials
- D. Record Documents

1.07 QUALITY ASSURANCE

- A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code
- C. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

- D. Installer Qualifications for Powder-Actuated Fasteners (when specified): Certified by fastener system manufacturer with current operator's license.
- E. Installer Qualifications for Field-Welding: As specified in Section 05 50 00.
- F. Installer's Qualifications: Include evidence of compliance with specified requirements.

1.08 COORDINATION

- A. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
- B. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
- C. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
- D. Coordinate the work with other trades to provide additional framing and materials required for installation.
- E. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
- F. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
- G. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- H. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured in accordance with Section {CH#104419}.

1.09 DELIVERY, STORAGE AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 METAL PIPE HANGERS AND SUPPORTS

- A. Manufacturers:
 - 1. AAA Technology & Specialties Co., Inc.
 - 2. Anvil International.
 - 3. Bergen-Power Pipe Supports.
 - 4. B-Line Systems, Inc.; a division of Cooper Industries.
 - 5. Carpenter & Paterson, Inc.
 - 6. Empire Industries, Inc.
 - 7. ERICO/Michigan Hanger Co.
 - 8. Globe Pipe Hanger Products, Inc.
 - 9. Grinnell Corp.
 - 10. GS Metals Corp.
 - 11. National Pipe Hanger Corporation.
 - 12. PHD Manufacturing, Inc.
 - 13. PHS Industries, Inc.
 - 14. Piping Technology & Products, Inc.
 - 15. Tolco Inc.
- B. Carbon-Steel Pipe Hangers and Supports:
 - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
 - 2. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.
 - 3. Non-metallic Coatings: Plastic coating, jacket, or liner.
 - 4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.

5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
- C. Stainless-Steel Pipe Hangers and Supports:
 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
 2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
 3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.
- D. Copper Pipe Hangers:
 1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
 2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

2.02 TRAPEZE PIPE HANGERS

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

2.03 FIBERGLASS PIPE HANGERS

- A. Manufacturers:
 1. Plasti-Fab, Inc.
- B. Clevis-Type, Fiberglass Pipe Hangers:
 1. Description: Similar to MSS SP-58, Type 1 steel pipe hanger, except hanger is made of fiberglass or fiberglass-reinforced resin.
 2. Hanger Rods: Continuous-thread rod, washer, and nuts made of fiberglass, polyurethane, or stainless steel.
 3. Flammability: ASTM D635, ASTM E84, UL 94.
- C. Strap-Type, Fiberglass Pipe Hangers:
 1. Description: Similar to MSS SP-58, Type 9 or Type 10 steel pipe hanger, except hanger is made of fiberglass-reinforced resin.
 - a. Flammability: ASTM D635, ASTM E84, UL 94.
 2. Hanger Rod and Fittings: Continuous-thread rod, washer, and nuts made of stainless steel.

2.04 METAL FRAMING SYSTEMS

- A. Manufacturers:
 1. Anvil International.
 2. B-Line Systems, Inc.; a division of Cooper Industries.
 3. ERICO/Michigan Hanger Co.; ERISTRUT Div.
 4. GS Metals Corp.
 5. Power-Strut Div.; Tyco International, Ltd.
 6. Thomas & Betts Corporation.
 7. Tolco Inc.
 8. Unistrut Corp.; Tyco International, Ltd.
- B. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
- C. Standard: MFMA-4.
- D. Channels: Continuous slotted steel channel with inturned lips.
- E. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
- F. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
- G. Metallic Coating: Hot-dipped galvanized.

H. Paint Coating: Epoxy

2.05 FIBERGLASS STRUT SYSTEMS

- A. Manufacturers:
 - 1. Anvil International.
 - 2. B-Line Systems, Inc.; a division of Cooper Industries.
 - 3. Champion Fiberglass, Inc.
 - 4. Cope, T. J., Inc.; Tyco International Ltd.
 - 5. Seasafe, Inc.
- B. Description: Structural-grade, factory-formed, glass-fiber-resin channels and angles for supporting multiple parallel pipes.
- C. Standard: Comply with MFMA-4, factory-fabricated components for field assembly.
- D. Channels: Continuous slotted fiberglass-reinforced plastic channel with intumed lips.
- E. Channel Width: Selected for applicable load criteria.
- F. Fittings and Accessories: Products provided by channel and angle manufacturer and designed for use with those items.
- G. Fitting and Accessory Materials: Same as those for channels and angles, except metal items may be stainless steel.
- H. Rated Strength: Selected to suit applicable load criteria.
- I. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

2.06 THERMAL-HANGER SHEILD INSERTS

- A. Manufacturers:
 - 1. Carpenter & Paterson, Inc.
 - 2. Clement Support Services.
 - 3. ERICO/Michigan Hanger Co.
 - 4. National Pipe Hanger Corporation.
 - 5. PHS Industries, Inc.
 - 6. Pipe Shields, Inc., a subsidiary of Piping Technology & Products, Inc.
 - 7. Piping Technology & Products, Inc.
 - 8. Rilco Manufacturing Company, Inc.
 - 9. Value Engineered Products, Inc.
- B. Insulation-Insert Material for Cold Piping: ASTM C552, Type II cellular glass with 100-psig or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.
- C. Insulation-Insert Material for Hot Piping: ASTM C552 ASTM C 552, Type II cellular glass with 100-psig or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.
- D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature

2.07 FASTENER SYSTEMS

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

- a. Hilti, Inc.
 - b. ITW Ramset/Red Head.
 - c. Masterset Fastening Systems, Inc.
 - d. MKT Fastening, LLC.
 - e. Powers Fasteners.
- B. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated steel, for use in hardened Portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
- 1. Manufacturers:
 - a. B-Line Systems, Inc.; a division of Cooper Industries.
 - b. Empire Industries, Inc.
 - c. Hilti, Inc.
 - d. ITW Ramset/Red Head.
 - e. MKT Fastening, LLC.
 - f. Powers Fasteners.
- C. Outdoor Applications: Stainless steel.

2.08 PIPE STANDS

- A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.
- B. Compact Pipe Stand:
- 1. Description: Single base unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
- C. Base: Single, vulcanized rubber, molded polypropylene, or polycarbonate.
- D. Hardware: Galvanized steel or polycarbonate.
- E. Accessories: Protection pads.
- F. Low-Profile, Single-Base, Single-Pipe Stand:
- G. Description: Single base with vertical and horizontal members, and pipe support, for roof installation without membrane protection.
- H. Base: Single, vulcanized rubber, molded polypropylene, or polycarbonate.
- 1. Vertical Members: Two galvanized-steel, continuous-thread, 1/2-inch rods.
 - 2. Horizontal Member: Adjustable horizontal, galvanized-steel pipe support channels.
 - 3. Pipe Supports: Roller.
 - 4. Hardware: Galvanized steel.
- I. Accessories: Protection pads.
- 1. Height: 12 inches above roof.
- J. High-Profile, Single-Base, Single-Pipe Stand:
- K. Description: Single base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
- L. Base: Single vulcanized rubber or molded polypropylene.
- 1. Vertical Members: Two galvanized-steel, continuous-thread, 1/2-inch rods.
 - 2. Horizontal Member: One adjustable-height, galvanized or stainless-steel, pipe-support slotted channel or plate.
 - 3. Pipe Supports: Roller.
 - 4. Hardware: Galvanized steel.
 - 5. Accessories: Protection pads, 1/2-inch, continuous-thread, galvanized-steel rod.
 - 6. Height: 36 inches above roof.
- M. High-Profile, Multiple-Pipe Stand:

1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
 2. Bases: Two or more; vulcanized rubber.
 3. Vertical Members: Two or more, galvanized-steel channels.
 4. Horizontal Members: One or more, adjustable-height, galvanized-steel pipe support.
 5. Pipe Supports: Roller.
 6. Hardware: Galvanized steel.
 7. Accessories: Protection pads, 1/2-inch, continuous-thread rod.
 8. Height: 36 inches above roof.
- N. Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.
- O. Pipe Stands, General: Shop or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping, ductwork and equipment.

2.09 PIPE POSITIONING SYSTEMS

- A. Manufacturers:
1. C & S Mfg. Corp.
 2. HOLDRITE Corp.; Hubbard Enterprises.
 3. Samco Stamping, Inc.
 4. Sioux Chief Manufacturing Co.
- B. Description: IAPMO PS 42, system of metal brackets, clips, and straps for positioning piping in pipe spaces for plumbing fixtures for commercial applications.

2.10 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel or stainless steel shapes with appropriate finish based on location of use.

2.11 MISCELLANEOUS MATERIALS

- A. Aluminum: ASTM B221.
- B. Carbon Steel: ASTM A1011/A1011M.
- C. Structural Steel: ASTM A36/A36M, steel plates, shapes, and bars; black and galvanized.
- D. Stainless Steel: ASTM A304, stainless steel plates, shapes, and bars.
- E. Grout: ASTM C1107/C1107M, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and non-metallic grout; suitable for interior and exterior applications.
1. Properties: Nonstaining, noncorrosive, and nongaseous.
 2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

2.12 ROOF CURBS FOR PIPING AND EQUIPMENT SUPPORT

- A. Wood blocking or other materials placed directly on roof to support piping or equipment is not acceptable.
- B. Roof Curbs: Internally reinforced roof-curb units capable of supporting superimposed live and dead loads, including equipment loads and other construction indicated on Drawings; with welded or mechanically fastened and sealed corner joints, stepped integral metal cant raised the thickness of roof insulation, and integrally formed deck-mounting flange at perimeter bottom.
1. Manufacturers:
 - a. Greenheck Fan Corporation.
 - b. Milcor Inc.; Commercial Products Group of Hart & Cooley, Inc.
 - c. Pate Company (The).
 - d. Thybar Corporation.

- e. Vent Products Co., Inc.
- C. Size: Coordinate dimensions with roughing-in information or Shop Drawings of equipment to be supported.
- D. Loads: _____.
- E. Material: Zinc-coated (galvanized) steel sheet, 0.079 inch thick.
- F. Construction:
 - 1. Insulation: Factory insulated with 1-1/2-inch- thick glass-fiber board insulation.
 - 2. Liner: Same material as curb, of manufacturer's standard thickness and finish.
 - 3. Factory-installed wood nailer at top of curb, continuous around curb perimeter.
 - 4. On ribbed or fluted metal roofs, form deck-mounting flange at perimeter bottom to conform to roof profile.
 - 5. Fabricate curbs to minimum height of 12 inches unless otherwise indicated.
 - 6. Top Surface: Level around perimeter with roof slope accommodated by sloping the deck-mounting flange.
 - 7. Sloping Roofs: Where roof slope exceeds 1:48, fabricate curb with perimeter curb height tapered to accommodate roof slope so that top surface of perimeter curb is level. Equip unit with water diverter or cricket on side that obstructs water flow.
 - 8. Security Grille: Provide where indicated.

PART 3 EXECUTION

3.01 APPLICATION

- A. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation, for penetrations through fire-rated walls, ceilings, and assemblies.
- B. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
- C. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.
- D. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.
- E. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.
- F. Use padded hangers for piping that is subject to scratching.
- G. Holes shall not be drilled or punched in beams and supporting members. Do not support piping from roof deck, other piping, ducts, or equipment.
- H. Hangers and supports shall also be provided at every change in direction and within 12 inches of any pipe fitting and valves.
- I. Pipe hangers in fan rooms and in mechanical equipment rooms shall be provided with spring hangers with elastomeric inserts to eliminate noise transmission between piping and the building structure. Refer to Division 20 Section "Vibration and Seismic Controls."
- J. Hanger components shall not be used for purposes other than for which they were designed.
- K. Pipe attachments for insulated pipe shall be outside the insulation. Insulation protection shields or high density insulation inserts shall be provided to protect the insulation.
- L. Provide necessary piping and equipment supporting elements including building structure attachments, supplementary steel, hanger rods, stanchions and fixtures, vertical pipe attachments, horizontal pipe attachments, anchors, guides, spring supports in accordance with

the referenced codes, standards, and requirements specified. Support piping and equipment from building structure, not from roof deck, floor slab, or other pipes, ducts, or equipment.

- M. Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- N. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size, or install intermediate supports for smaller-diameter pipes as specified for individual pipe hangers.
 - 2. Field fabricate from ASTM A36/A36M carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- O. Fiberglass Pipe-Hanger Installation: Comply with applicable portions of MSS SP-58. Install hangers and attachments as required to properly support piping from building structure.
- P. Framing System Installation: Metal; arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.
- Q. Thermal Hanger-Shield Installation: Install in pipe hanger or shield for insulated piping.
- R. Fastener System Installation:
 - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches (100 mm) thick in concrete, after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
 - 2. Install mechanical-expansion anchors in concrete, after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- S. Pipe Stand Installation:
 - 1. Pipe Stand Types, except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
 - 2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Section 077200 "Roof Accessories" for curbs.
- T. Pipe-Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.
- U. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- V. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- W. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- X. Install lateral bracing with pipe hangers and supports to prevent swaying.
- Y. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms, and install reinforcing bars through openings at top of inserts.
- Z. Load Distribution: Install hangers and supports, so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- AA. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- BB. Insulated Piping:
 - 1. Attach clamps and spacers to piping.

- a. Piping Operating Above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating Below Ambient Air Temperature: Use thermal hanger-shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
 2. MSS SP-58, Type 39: Install protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal hanger-shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.
 3. MSS SP-58, Type 40: Install protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal hanger-shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.
 4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90) NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): 12 inches long and 0.048 inch thick.
 - b. NPS 4 (DN 100): 12 inches long and 0.06 inch thick.
 - c. NPS 5 and NPS 6 (DN 125 and DN 150): 18 inches long and 0.06 inch thick.
 - d. NPS 8 to NPS 14 (DN 200 to DN 350): 24 inches long and 0.075 inch thick.
 - e. NPS 16 to NPS 24 (DN 400 to DN 600): 24 inches long and 0.105 inch thick.
 5. Pipes NPS 8 (DN 200) and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
 6. Thermal Hanger Shields: Install with insulation of same thickness as piping insulation.
- CC. Installation of Equipment Supports
1. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
 2. Grouting: Place grout under supports for equipment, and make bearing surface smooth.
 3. Provide lateral bracing, to prevent swaying, for equipment supports.
- DD. Metal Fabrications
1. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
 2. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
 3. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
 4. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 5. Obtain fusion without undercut or overlap.
 6. Remove welding flux immediately.
 7. Finish welds at exposed connections, so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.
- EE. Miscellaneous Materials
1. Supplementary Steel: Where it is necessary to frame structural members between existing structural steel members or where structural steel members are used in lieu of commercially rated supports, install such supplementary steel in accordance with American Institute of Steel Construction Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings. Connection to the existing steel shall be with clamps unless otherwise approved by the Engineer.

3.02 PAINTING

- A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).
- B. Touch Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Sections.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780/A780M.

3.03 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches (40 mm).

3.04 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-58 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finishes.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers, and metal framing systems and attachments for general service applications.
- F. Use stainless steel pipe hangers, fiberglass pipe hangers, and fiberglass strut systems and stainless steel or corrosion-resistant attachments for hostile environment applications.
- G. Use copper-plated pipe hangers and copper or stainless steel attachments for copper piping and tubing.
- H. Use padded hangers for piping that is subject to scratching.
- I. Use thermal hanger-shield inserts for insulated piping and tubing.
- J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
 - 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
 - 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
 - 4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
 - 5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
 - 6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
 - 7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
 - 8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.

9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction occurs.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction occurs.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction occurs but vertical adjustment is unnecessary.
- K. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction occurs and vertical adjustment is unnecessary.
 1. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation, in addition to expansion and contraction, is required.
- L. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.
- M. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 1. Steel Turnbuckles (MSS Type 13): For adjustment of up to 6 inches for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11 split pipe rings.
 4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- N. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 1. Steel or Malleable-Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.

4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
 13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
 15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- O. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal Hanger-Shield Inserts: For supporting insulated pipe.
- P. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
 2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
 3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
 4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
 5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
 6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
 7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
 8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
 - a. Horizontal (MSS Type 54): Mounted horizontally.
 - b. Vertical (MSS Type 55): Mounted vertically.

- c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.
- Q. Comply with MSS SP-58 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- R. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
- S. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.
- T. Use pipe-positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures

END OF SECTION

**SECTION 20 05 33
HEAT TRACING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Self-Regulating Parallel Resistance Electric Heating cable.
 - 1. Manufacturers
 - 2. Source Limitations
 - 3. Comply with IEEE 515.1.
 - 4. Heating Element
 - 5. Electrical Insulating Jacket
 - 6. Grounding Cover
 - 7. Cable Cover
 - 8. Terminate cable with waterproof, factory-assembled, non-heating leads with connectors at one end, and seal the opposite end watertight. Cable is to be capable of crossing over itself once without overheating.
 - 9. Maximum Operating Temperature (Power On)
 - 10. Maximum Exposure Temperature (Power Off)
 - 11. Electrical Components, Devices, and Accessories
 - 12. For freeze protection applications (HVAC, Plumbing, and Fire Protection)
 - 13. For domestic hot water temperature maintenance applications
 - 14. For kitchen/grease waste pipe temperature maintenance applications
- B. Plastic Insulated Series Resistance Electric Heating cable
 - 1. Manufacturers
 - 2. Provide products listed, classified, and labeled by UL (DIR)
 - 3. Factory Rating and Testing
 - 4. Heating Element
 - 5. Insulated Jacket
 - 6. Cable Cover
 - 7. Maximum Operating Temperature
 - 8. Electrical Characteristics
- C. Constant Wattage Resistance Electric Heating cable.
 - 1. Manufacturers
 - 2. Provide products listed, classified, and labeled by UL (DIR)
 - 3. Factory Rating and Testing: Comply with IEEE 515.1
 - 4. Heating Element
 - 5. Insulated Jacket
 - 6. Cable Cover
 - 7. Maximum Operating Temperature
 - 8. Electrical Characteristics
- D. Outer Jacket Markings
 - 1. Name of manufacturer, trademark, or other recognized symbol of identification
 - 2. Catalog number, reference number, or model
 - 3. Month and year of manufacture, date coding, applicable serial number, or equivalent
 - 4. Agency listing or approval
 - 5. Applicable environmental or area use requirements, such as NEMA 4, Type 4, IP ratings, and hazardous (classified) location markings including temperature rating
 - 6. Any applicable warning/caution statements such as "WARNING"
- E. Connection Kits
 - 1. Name of manufacturer, trademark, or other recognized symbol of identification

2. Provide power connection, splice/tee, end seal, and [] kits compatible with the heating cable and without requiring cutting of the cable core to expose bus wires.
 3. Furnish with NEMA 4X rating for prevention of corrosion and water ingress
 4. Provide UV stabilized components
- F. Accessories
1. All heat tracing accessories shall be furnished by the manufacturer of the heat tracing used, or as recommended in writing by the manufacturer of the heat tracing used
 2. Cable Installation Accessories
 3. Warning Labels
 4. Warning Tape
 5. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches: 3/4 inch minimum
 6. Width for Markers on Pipes with OD, Including Insulation, 6 Inches or Larger: 1-1/2 inches minimum
- G. Controls
1. Pipe-Mounted Thermostats for Freeze Protection
 2. Control Panel
 3. Ground-fault protection
 4. Precipitation and Temperature Sensor for Snow Melting on Roofs and in Gutters
 5. Programmable Timer for Domestic Hot-Water-Temperature Maintenance
 6. Relays with contacts to indicate operational status, on or off, and for interface with central HVAC control-system workstation
 7. Heat Tracing for Fire Protection Systems: Self-Regulating Parallel Resistance Electric Heating Cable

1.02 RELATED REQUIREMENTS

- A. Section 23 05 53 - Identification for HVAC Piping and Equipment.
- B. Section 23 07 19 - HVAC Piping Insulation.
- C. Section 23 09 13 - Instrumentation and Control Devices for HVAC.
- D. Section 23 09 23 - Direct-Digital Control System for HVAC.
- E. Section 23 09 93 - Sequence of Operations for HVAC Controls.
- F. Section 23 11 13 - Facility Fuel-Oil Piping.
- G. Section 23 21 13 - Hydronic Piping.
- H. Section 23 21 14 - Hydronic Specialties.
- I. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.
- J. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- K. Section 26 05 33.13 - Conduit for Electrical Systems.
- L. Section 26 05 33.16 - Boxes for Electrical Systems.
- M. Section 26 05 83 - Wiring Connections.

1.03 REFERENCE STANDARDS

- A. IEEE 515.1 - IEEE Standard for the Testing, Design, Installation, and Maintenance of Electrical Resistance Trace Heating for Commercial Applications; 2022.
- B. ITS (DIR) - Directory of Listed Products; Current Edition.
- C. NEMA 4 - x; x.
- D. NFPA 13 - Standard for the Installation of Sprinkler Systems; 2022.
- E. {RSTEMP#undefined}

- F. UL (DIR) - Online Certifications Directory; Current Edition.

1.04 ABBREVIATIONS AND ACRONYMS

- A. AHJ: Authorities Having Jurisdiction.
- B. AWG: American Wire Gauge.
- C. FM: Factory Mutual Global.
- D. Hz: Hertz.
- E. IEEE: Institute of Electrical and Electronic Engineers.
- F. IP: Ingress Protection.
- G. NEMA: National Electrical Manufacturers Association.
- H. NICET: National Institute for Certification in Engineering Technologies.
- I. NFPA: National Fire Protection Association.
- J. OD: Outside Diameter.
- K. UL: Underwriters Laboratories.
- L. UV: Ultraviolet.
- M. VDC: Volts Direct Current.
- N. W/ft: Watts per foot.

1.05 PERFORMANCE REQUIREMENTS

- A. Performance Requirements for Heat Trace on Fire Protection Systems.
- B. Regulatory Requirements: Comply with local building codes and standards of all authorities having jurisdiction for design and installation of heat tracing systems used on fire protection systems.
 - 1. NFPA Compliance: Comply with NFPA 13 and NFPA 14 for heat tracing design and installation.
 - 2. Heat Tracing System Components, Devices, and Accessories: Listed in UL's Fire Protection Equipment directory and FM Global's "Approval Guide".
 - 3. Heat tracing shall be listed for use on fire protection piping.
 - 4. Heat tracing used on sprinkler branch lines shall be specifically listed for use on sprinkler branch lines.
 - 5. Self-regulating cable shall be designed for a useful life of 20 years or more.
 - 6. Delegated Design: Engage a qualified professional engineer or NICET certified technician with appropriate certified NICET level as required by the local jurisdiction to design fire protection heat tracing systems.
 - 7. Obtain documented approval of the fire protection heat trace system design from the AHJ.

1.06 SUBMITTALS

- 1. Product Data:
 - a. For each type of product:
 - 1) Include construction details, material descriptions, dimensions of individual components and profiles.
 - 2) Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
 - 3) Schedule heating capacity, length of cable, spacing, and electric power requirements for each electric heating cable required.
 - 4) Schedule heating capacity, length of cable, spacing, and electrical power requirement for each electric heating cable required.

- 5) Separate submittal packages are required for Freeze Protection, Domestic Hot Water Piping Temperature Maintenance, and Grease Waste Piping Temperature Maintenance applications.
2. Shop Drawings, For electric heating cable:
 - a. Include plans, elevations, sections and attachment details.
 - b. Indicate dimensions, required clearances, method of field assembly, components, electrical characteristics, and location and size of each field connection.
 - c. Include diagrams for power, signal, and control wiring.
3. Fire Protection Delegated Design Submittals: Submit documents and calculations for heat tracing to conform with performance requirements and design criteria, including analysis data, signed, and sealed by the qualified professional engineer responsible for their preparation or prepared by NICET certified technician with appropriate certified NICET level as required by the local jurisdiction. NICET certified technician submittals are to include the following information on each drawing title block: technician's name, NICET certification number, and NICET certification specialty area and level.
4. Required Embodied Carbon Submittals: All products which satisfy one of the following criteria will require an Embodied Carbon Submittal:
 - a. The product is a 'Major' piece of equipment
 - b. The product contains refrigerant
 - c. The cost of a group of products serving a given function constitutes 5% or greater of the sub-contractor's budget, excluding labor.
5. Embodied Carbon Submittals
 - a. Order of Preferred Submittals: For products which require an embodied carbon submittal (described above), one of the following must be provided. The submittal must be that with the highest preference available. The order preference, from highest to lowest is:
 - 1) Product Specific, Facility Specific EPD
 - 2) Product Specific EPD
 - 3) Industry Average EPD
 - 4) TM65 Manufacturer Form with Mid-Level Calculation data
 - 5) TM65 Manufacturer Form with Basic Calculation data
- B. Informational Submittals
 1. Coordination Drawings: Heat tracing system plans and sections, or Building Information Model (BIM), drawn to scale, showing the items described in this Section and coordinated with all building trades.
 2. Qualification Data: For qualified installer and designer.
 3. Field test reports.
 4. Field quality control reports.
 5. Design Data: Approved fire protection working plans, prepared in accordance with NFPA 13 and NFPA 70, including documented approval by AHJ, and including heat tracing electrical load calculations.
 6. Sample Warranties.
- C. Closeout Submittals
 1. Operation and Maintenance Data: For electric heating cables and controls to include in operation and maintenance manuals.
 2. Include manufacturer's descriptive literature, operating instructions, cleaning procedures, replacement parts list, maintenance data, and repair data.
- D. Record Documents
 1. Record as-built drawings.
 2. Record heat tracing load calculations.
 3. Record digital files.
 4. Digital layout models.

5. Product data.
6. Final Submittals with responses.

1.07 WARRANTIES

- A. Special Warranty: Manufacturer agrees to repair or replace electrical heating cable that fails in materials or workmanship within specified warranty period.
 1. Warranty Period: Three years from date of Substantial Completion.

1.08 COORDINATION

- A. Coordinate the work with other trades to provide ground fault protection for electric heat tracing circuits as required by NFPA 70.
- B. Coordinate the work with other trades to provide circuit breaker ratings suitable for installed circuit lengths.

1.09 DELIVERY, STORAGE AND HANDLING

- A. Store products in shipping containers until installation.

PART 2 PRODUCTS

2.01 SELF-REGULATING PARALLEL RESISTANCE ELECTRIC HEATING CABLE

- A. Manufacturers:
 1. BriskHeat.
 2. Chromalox, Inc.
 3. Delta-Therm Corporation.
 4. EasyHeat; Emerson Electric Co., Commercial and Residential Solutions.
 5. RAYCHEM; brand of nVent Electrical plc.
 6. Thermon Americas Inc.
 7. Trasor Corp.
- B. Source Limitations: Obtain all heat tracing and system components from one manufacturer.
- C. Comply with IEEE 515.1.
- D. Heating Element: Pair of parallel No. 18 AWG, nickel-coated, stranded copper bus wires embedded in crosslinked conductive polymer core, which varies heat output in response to temperature along its length.
- E. Electrical Insulating Jacket: Flame-retardant polyolefin.
- F. Grounding Cover: Copper braid.
- G. Cable Cover: Polyolefin outer jacket with ultraviolet inhibitor.
- H. Terminate cable with waterproof, factory-assembled, non-heating leads with connectors at one end, and seal the opposite end watertight. Cable is to be capable of crossing over itself once without overheating.
- I. Maximum Operating Temperature (Power On): 150 deg F (65 deg C).
- J. Maximum Exposure Temperature (Power Off): 185 deg F (85 deg C).
- K. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70 by a qualified testing agency, and marked for intended location and application.
- L. For freeze protection applications (HVAC, Plumbing, and Fire Protection): The heater cable shall be sized according to the following table (based on the fiberglass insulation on a metal pipe at 40 deg F with an ambient temperature of -20 deg F). The power output is in watts per foot. The heating values expressed in the table below convey a design basis for the anticipated system maximum electrical load. A lesser value of W/foot may be submitted provided that the required design conditions of 40°F pipe surface temperature at a -20 deg F ambient, with the indicated insulation, will be maintained.

Table A

PIPE SIZE	MINIMUM POWER OUTPUT	INSULATION (MINIMUM THICKNESS)
4" or less	6 watts/foot	As specified in Division 20 "Mechanical Insulation".
6"	9 watts/foot	As specified in Division 20 "Mechanical Insulation".
8" to 10"	9 watts/foot	As specified in Division 20 "Mechanical Insulation" or 1-1/2", whichever is greater.
12" through 20"	2 strips - 9 watts/foot	As specified in Division 20 "Mechanical Insulation" or 1-1/2", whichever is greater.

- M. For domestic hot water temperature maintenance applications: The heater cable shall be sized according to the following table (based on the fiberglass insulation on a metal pipe at 125 deg F with an ambient temperature of 70 deg F). The power output is in watts per foot. The heating values expressed in the table below convey a design basis for the anticipated system maximum electrical load. A lesser value of W/foot may be submitted provided that the required design conditions of 125 deg F pipe surface temperature at a 70 deg F ambient, with the indicated insulation, will be maintained.

Table B

PIPE SIZE	MINIMUM POWER OUTLET	INSULATION (MINIMUM THICKNESS)
6" or less	9 watts/foot	As specified in Division 20 "Mechanical Insulation" or 1-1/2", whichever is greater.

- N. For kitchen/grease waste pipe temperature maintenance applications: The heater cable shall be sized according to the following table (based on the fiberglass insulation on a metal pipe at 85 deg F with an ambient temperature of -20 deg F. The power output is in watts per foot. The heating values expressed in the table below convey a design basis for the anticipated system maximum electrical load. A lesser value of W/foot may be submitted provided that the required design conditions of 85 deg F pipe surface temperature at a -20 deg F ambient, with the indicated insulation, will be maintained.

Table C

PIPE SIZE	MINIMUM POWER OUTLET	INSULATION (MINIMUM THICKNESS)
6" or less	9 watts/foot	As specified in Division 20 "Mechanical Insulation" or 1-1/2", whichever is greater.

2.02 PLASTIC INSULATED SERIES RESISTANCE ELECTRIC HEATING CABLE

- A. Manufacturers:
- Emerson Electric Co; _____: www.emerson.com/#sle.
 - Pentair Thermal Management; _____ www.pentairthermal.com
 - nVent Raychem ; _____ www.nvent.com
- B. Provide products listed, classified, and labeled by UL (DIR).
- C. Factory Rating and Testing: Comply with IEEE 515.
- D. Heating Element:
- Resistor Wire: Provide single.

2. Terminations: Waterproof, factory assembled, non-heating leads with connectors at both ends.
- E. Insulated Jacket: Minimum 4.0 mil (0.10 mm) polyimide film with silicon jacket or fluoropolymer resin.
- F. Cable Cover: Provide aluminum braid and silicon outer jacket.
- G. Maximum Operating Temperature: 300 degrees F (150 degrees C).
- H. Electrical Characteristics:
 1. _____ W/lineal ft (_____ W/lineal m).
 2. _____ volts, single phase, 60 Hz.

2.03 CONSTANT WATTAGE RESISTANCE ELECTRIC HEATING CABLE

- A. Manufacturers:
 1. Briskheat Corporation; _____: www.briskheat.com/#sle.
 2. Chromalox, Inc; _____: www.chromalox.com/#sle.
 3. Omega Engineering Inc; _____: www.omega.com/#sle.
- B. Provide products listed, classified, and labeled by UL (DIR).
- C. Factory Rating and Testing: Comply with IEEE 515.1.
- D. Heating Element:
 1. Provide pair of parallel No. 12 tinned, nickel-coated, or _____ stranded copper bus wires with single stranded resistor wire connected between bus wires.
 2. Terminations: Waterproof, factory assembled, non-heating leads with connector at one end and water-tight seal at opposite end.
- E. Insulated Jacket: Flame retardant fluoropolymer.
- F. Cable Cover: Provide tinned copper and polyolefin outer jacket with UV inhibitor.
- G. Maximum Operating Temperature: 392 degrees F (200 degrees C).
- H. Electrical Characteristics:
 1. _____ W/lineal ft (_____ W/lineal m).
 2. _____ volts, single phase, 60 Hz.

2.04 OUTER JACKET MARKINGS

- A. Name of manufacturer, trademark, or other recognized symbol of identification.
- B. Catalog number, reference number, or model.
- C. Month and year of manufacture, date coding, applicable serial number, or equivalent.
- D. Agency listing or approval.
- E. Applicable environmental or area use requirements, such as NEMA 4, Type 4, IP ratings, and hazardous (classified) location markings including temperature rating.
- F. Any applicable warning/caution statements such as "WARNING: De-energize circuit before removing cover.

2.05 CONNECTION KITS

- A. Name of manufacturer, trademark, or other recognized symbol of identification.
- B. Provide power connection, splice/tee, end seal, and _____ kits compatible with the heating cable and without requiring cutting of the cable core to expose bus wires.
- C. Furnish with NEMA 4X rating for prevention of corrosion and water ingress.
- D. Provide UV stabilized components.

2.06 ACCESSORIES

- A. All heat tracing accessories shall be furnished by the manufacturer of the heat tracing used, or as recommended in writing by the manufacturer of the heat tracing used.
- B. Cable Installation Accessories: Fiberglass tape, heat-conductive putty, cable ties, silicone end seals and splice kits, and installation clips all furnished by manufacturer, or as recommended in writing by manufacturer.
- C. Warning Labels: Refer to Division 20 "Identification for Mechanical Piping and Equipment."
- D. Warning Tape: Continuously printed "Electrical Tracing"; vinyl, at least 3 mils thick, and with pressure-sensitive, permanent, waterproof, self-adhesive back.
- E. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches: 3/4 inch minimum.
- F. Width for Markers on Pipes with OD, Including Insulation, 6 Inches or Larger: 1-1/2 inches minimum

2.07 CONTROLS

- A. Pipe-Mounted Thermostats for Freeze Protection:
 - 1. Remote bulb unit with adjustable temperature range from 30 to 50 deg F.
 - 2. Snap action; open-on-rise, single-pole switch with minimum current rating adequate for connected cable.
- B. Control Panel:
 - 1. Microprocessor-based control with manual on, automatic, and standby/reset switch.
 - 2. Corrosion-proof and waterproof enclosure suitable for outdoor mounting, for controls and temperature sensors.
 - 3. Minimum 30 A contactor to energize cable or close other contactors.
 - 4. Single-point control of heat tracing for freeze protection and domestic hot-water-temperature maintenance.
 - 5. Remote temperature sensor senses domestic hot water temperature: programmable to control the domestic hot water temperature at hot water system delivery temperature.
 - 6. Remote temperature sensor senses outside air temperature; programmable to energize the freeze-protection cable when temperature falls below 34 to 44 deg F.
- C. Ground-fault protection.
 - 1. Remote bulb on capillary, resistance temperature device, or thermistor for directly sensing pipe-wall temperature.
 - 2. Corrosion-resistant, waterproof control enclosure.
- D. Precipitation and Temperature Sensor for Snow Melting on Roofs and in Gutters:
 - 1. Microprocessor-based control with manual on, automatic, and standby/reset switch.
 - 2. Precipitation and temperature sensors shall sense the surface conditions of roof and gutters and shall be programmed to energize the cable as follows:
 - a. Temperature Span: 34 to 44 deg F.
 - b. Adjustable Delay-Off Span: 30 to 90 minutes.
 - c. Energize Cables: Following two-minute delay if ambient temperature is below set point and precipitation is detected.
 - 3. Provide communication ports with contacts, RS485, or Ethernet interface for remote monitoring and alarm by central HVAC-control system. Coordinate type of connection ports with Section 230923 "Direct Digital Control (DDC) System for HVAC."
- E. Programmable Timer for Domestic Hot-Water-Temperature Maintenance:
 - a. De-Energize Cables: On detection of a dry surface plus time delay.
 - 2. Corrosion-proof and waterproof enclosure suitable for outdoor mounting, for controls and precipitation and temperature sensors.
 - 3. Minimum of four separate schedules.
 - 4. Minimum 24-hour battery carryover.

5. On-off-auto switch.
6. 365-day calendar with 20 programmable holidays.
- F. Relays with contacts to indicate operational status, on or off, and for interface with central HVAC control-system workstation.
 1. Microprocessor based.
 2. Minimum 30-A contactor to energize cable or close other contactors.
 3. Precipitation sensor shall be freestanding.
 4. Provide relay with contacts to indicate operational status, on or off, for interface with central HVAC control-system workstation.
 5. Examine surfaces and substrates for compliance with requirements for installation tolerances and other conditions affecting performance.
 6. Ensure surfaces and pipes in contact with electric heating cables are free of burrs and sharp protrusions.

PART 3 EXECUTION

- A. Verify that piping and equipment are ready to receive work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. Verify field measurements are as indicated on shop drawings.
- D. Verify required power is available, in proper location, and ready for use.

3.02 PREPARATION

- A. Clean all surfaces prior to installation.
- B. Prepare surfaces using the methods recommended by the manufacturer.
- C. Install electric heating cable at locations indicated and in accordance with NFPA 70.
- D. Install electric heating cable across expansion, construction, and control joints in accordance with manufacturer's written instructions; use cable-protection conduit and slack cable to allow movement without damage to cable.
- E. Install electric heating cables after piping has been tested and before insulation is installed.
- F. Install electric heating cables in accordance with IEEE 515.1.
- G. Install insulation over piping with electric cables in accordance with Section 220719 "Plumbing Piping Insulation."
- H. Install warning tape on piping insulation where piping is equipped with electric heating cables.
- I. Set field-adjustable switches and circuit-breaker trip ranges.
- J. Install temperature-control units in an accessible location and in accordance with manufacturer's written instructions. Locate sensing bulbs to sense outside air temperature in a location where it will not be affected by direct sunlight or other heat sources.

3.03 INSTALLATION

- A. Double Containment Fuel Oil Piping:
 1. Apply trace heating cabling to outer surface of containment pipe under the thermal insulation.
 2. Prefabricated/Preinsulated Piping:
 - a. Install trace heating cabling within channels provided by the piping manufacturer on the outer surface of the containment pipe.
- B. Install control panels and distribution panels where indicated and in accordance with manufacturer's written instructions.
- C. Install and connect outside air and pipe temperature sensors
 - a. Avoid splicing unless required to prevent exceeding the maximum pulling force of the trace cabling.

3.04 CONNECTIONS

1. Ground equipment in accordance with Section 26 05 26 - Grounding and Bonding for Electrical Systems.
2. Connect temperature-control unit for freeze protection to interrupt power supply to electric heating cable when outside air is above set point.
3. Connect temperature-control unit for domestic hot-water-temperature maintenance to interrupt power supply to electric heating cable when hot water is above set point.
4. Connect wiring in accordance with Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.
5. Connect remote electronic temperature sensors.

3.05 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Protect installed heating cables, including non-heating leads, from damage.
- D. Remove and replace damaged heat-tracing cables.

3.06 IDENTIFICATION

- A. After thermal insulation installation, apply external pipeline decals to indicate presence of the thermal insulation cladding at intervals not to exceed 20 ft (6 m) including cladding over each valve or other equipment that may require maintenance.

3.07 DEMONSTRATION AND TRAINING

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate and maintain heat tracing systems.

END OF SECTION

SECTION 20 05 48
VIBRATION AND SEISMIC CONTROLS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Elastomeric isolation pads
 - 1. Manufacturers
 - 2. Fabrication
 - 3. Size
 - 4. Pad Material
 - 5. Surface Pattern
 - 6. Infused nonwoven cotton or synthetic fibers
 - 7. Load-bearing metal plates adhered to pads
 - 8. Sandwich-Core Material: Resilient and elastomeric.
- B. Elastomeric isolation mounts.
 - 1. Double-Deflection, Elastomeric Isolation Mounts
- C. Restrained elastomeric isolation mounts.
 - 1. Manufacturers
 - 2. Description
 - 3. Housing
 - 4. Elastomeric Material
- D. Open-spring isolators
 - 1. Freestanding, Laterally Stable, Open-Spring Isolators
- E. Housed-spring isolators
 - 1. Freestanding, Laterally Stable, Open-Spring Isolators in Two-Part Telescoping Housing
- F. Freestanding spring isolators
 - 1. Freestanding, Laterally Stable, Open-Spring Isolators with Vertical-Limit Stop Restraint
- G. Restrained-spring isolators.
 - 1. Freestanding, Laterally Stable, Open-Spring Isolators with Vertical-Limit Stop Restraint
- H. Housed-restrained-spring isolators
 - 1. Freestanding, Steel, Open-Spring Isolators with Vertical-Limit Stop Restraint in Two-Part Telescoping Housing
- I. Pipe-riser resilient supports.
 - 1. Description
- J. Resilient pipe guides
 - 1. Description
- K. Air-spring isolators
 - 1. Freestanding, Single or Multiple, Compressed-Air Bellows
- L. Restrained-air-spring isolators
 - 1. Freestanding, Single or Multiple, Compressed-Air Bellows with Vertical-Limit Stop Restraint
- M. Elastomeric hangers
 - 1. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods
- N. Spring hangers
 - 1. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression

- 2. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression with vertical limit stop
- O. Snubbers
 - 1. Manufacturers
 - 2. Description
- P. Seismic expansion loops
 - 1. Manufacturers
 - 2. Description
 - 3. Listing and Pressure Rating
- Q. Restraint channel bracings
 - 1. Manufacturers
 - 2. Description
- R. Restraint cables
 - 1. Manufacturers
 - 2. Restraint Cables
- S. Seismic-restraint accessories
 - 1. Manufacturers
 - 2. Hanger-Rod Stiffener
 - 3. Hinged and Swivel Brace Attachments
 - 4. Bushings for Floor-Mounted Equipment Anchor Bolts
 - 5. Bushing Assemblies for Wall-Mounted Equipment Anchorage
 - 6. Resilient Isolation Washers and Bushings
- T. Mechanical anchor bolts
 - 1. Manufacturers
 - 2. Mechanical Anchor Bolts
- U. Adhesive anchor bolts
 - 1. Manufacturers
 - 2. Adhesive Anchor Bolts
- V. Vibration isolation equipment bases
 - 1. Manufacturers
 - 2. Steel Rails
 - 3. Steel Bases
 - 4. Concrete Inertia Base
- W. Restrained Isolation Roof-Curb Rails
 - 1. Manufacturers
 - 2. Description
 - 3. Upper Frame
 - 4. Lower Support Assembly
 - 5. Snubber Bushings
 - 6. Water Seal

1.02 REFERENCE STANDARDS

- A. International Building Code
- B. International Fire Code
- C. SMACNA
- D. 29 CFR 1910.7 - Testing Laboratory; Approved Edition.
- E. ASCE/SEI 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures; 2016.

- F. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.
- G. ASTM A492 - Standard Specification for Stainless Steel Rope Wire; 1995 (Reapproved 2019).
- H. ASTM A603 - Standard Specification for Metallic-Coated Steel Structural Wire Rope; 2019.
- I. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2024.
- J. ASTM E488/E488M - Standard Test Methods for Strength of Anchors in Concrete Elements; 2022.
- K. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2025.
- L. MFMA-4 - Metal Framing Standards Publication; 2004.
- M. MSS SP-127 - Bracing for Piping Systems: Seismic-Wind-Dynamic Design, Selection, and Application; Approved Edition.
- N. NFPA 13 - Standard for the Installation of Sprinkler Systems; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- O. {RSTEMP#2158}

1.03 ABBREVIATIONS AND ACRONYMS

- A. ASCE: American Society of Civil Engineers.
- B. ASTM: American Society for Testing and Materials.
- C. AWS: American Welding Society.
- D. CFR: Code of Federal Regulations (U.S.)
- E. FM: Factory Mutual.
- F. Hz: Hertz.
- G. IBC: International Building Code.
- H. ICC-ES: International Code Council – Evaluation Service.
- I. MFMA: Metal Framing Manufacturers Association.
- J. NRTL: Nationally Recognized Testing Laboratory.
- K. OSHA: Occupational Safety and Health Administration.
- L. OSHPD: Office of Statewide Health Planning & Development (for the State of California).
- M. PVC: Polyvinyl Chloride.
- N. PSIG: Pound-Force per Square Inch – Gauge.
- O. SEI: Structural Engineering Institute.
- P. UL: Underwriters Laboratories.

1.04 PERFORMANCE REQUIREMENTS

- A. Wind-Restraint Loading:
 - 1. Basic Wind Speed: _____.
 - 2. Building Classification Category: I.
 - 3. Minimum 10 lb/sq. ft. (48.8 kg/sq. m) multiplied by maximum area of HVAC component projected on vertical plane normal to wind direction, and 45 degrees either side of normal.
- B. Seismic-Restraint Loading:
 - 1. Site Class as Defined in the IBC: A.
 - 2. Assigned Seismic Use Group or Building Category as Defined in the IBC: I.
 - a. Component Importance Factor: 1.0.
 - b. Component Response Modification Factor: 1.5.
 - c. Component Amplification Factor: 1.0.

3. Design Spectral Response Acceleration at Short Periods (0.2 Second): _____.
4. Design Spectral Response Acceleration at 1.0-Second Period: _____.
5. Rated strengths, features, and applications shall be as defined in reports by an evaluation service member of ICC-ES.
 - a. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they are subjected.
- C. Delegated Design for Fire Protection Systems Seismic Bracing:
 1. Seismic Performance: Piping and equipment must be designed and secured to withstand the effects of earthquake motions determined in accordance with NFPA 13 and ASCE/SEI 7.
 2. Perform calculations to obtain force information necessary to properly select seismic-restraint devices, fasteners, and anchorage. Perform calculations using methods acceptable to applicable code authorities and as presented in NFPA 13 and ASCE/SEI 7 ASCE/SEI-7.
- D. Component Importance Factor for all fire protection system components: 1.5.
 1. Consequential Damage: Provide additional seismic restraints for fire protection system components as indicated in ASCE/SEI 7 so that failure of a non-essential or essential fire protection system component will not cause the failure of any other essential architectural, mechanical, or electrical building component.
- E. Fire/Smoke Resistance: Seismic restraint devices that are not constructed of ferrous metals must have a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested by an NRTL in accordance with ASTM E84 or {RS#2158} and be so labeled.
- F. Component Supports:
 1. Load ratings, features, and applications of all reinforcement components shall be based on testing standards of an NRTL.
 2. All component support attachments shall comply with force and displacement resistance requirements of ASCE/SEI 7.

1.05 SUBMITTALS

- A. Action Submittals
 1. Product Data: For each type of product.
 - a. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
 - b. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device and seismic-restraint component required.
 - 1) Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an evaluation service member of ICC-ES.
 - 2) Annotate to indicate application of each product submitted and compliance with requirements.
 - c. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.
 2. Shop Drawings:
 - a. Detail fabrication and assembly of equipment bases. Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
 - b. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
 3. Delegated-Design Submittal: For each vibration isolation and seismic-restraint device.
 - a. Include design calculations and details for selecting vibration isolators, seismic restraints, and vibration isolation bases complying with performance requirements,

- design criteria, and analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- b. Design Calculations: Calculate static and dynamic loading due to equipment weight, operation, and seismic and wind forces required to select vibration isolators and seismic and wind restraints and for designing vibration isolation bases.
 - 1) Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.
 - c. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system was examined for excessive stress and that none exists.
 - d. Post-Installed Concrete Anchors and Inserts: Include calculations showing anticipated seismic loads. Include certification that device is approved by an NRTL for seismic reinforcement use.
 - e. Seismic and Wind-Restraint Details:
 - 1) Design Analysis: To support selection and arrangement of seismic and wind restraints. Include calculations of combined tensile and shear loads.
 - 2) Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
 - 3) Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.
 - 4) Preapproval and Evaluation Documentation: By an evaluation service member of ICC-ES, showing maximum ratings of restraint items and the basis for approval (tests or calculations).
4. Required Embodied Carbon Submittals: All products which satisfy one of the following criteria will require an Embodied Carbon Submittal:
- a. The product is a 'Major' piece of equipment
 - b. The product contains refrigerant
 - c. The cost of a group of products serving a given function constitutes 5% or greater of the sub-contractor's budget, excluding labor.
5. Embodied Carbon Submittals
- a. Order of Preferred Submittals: For products which require an embodied carbon submittal (described above), one of the following must be provided. The submittal must be that with the highest preference available. The order preference, from highest to lowest is:
 - 1) Product Specific, Facility Specific EPD
 - 2) Product Specific EPD
 - 3) Industry Average EPD
 - 4) TM65 Manufacturer Form with Mid-Level Calculation data
 - 5) TM65 Manufacturer Form with Basic Calculation data
6. Coordination drawings: Show coordination of vibration isolation installation and seismic bracing for all piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.
7. Qualification Data: For professional engineer and testing agency.
8. Welding certificates.
9. Air-Mounting System Performance Certification: Include natural frequency, load, and damping test data performed by an independent agency
10. Field quality control reports.

11. Seismic Qualification Data: Provide special certification for designated seismic systems as indicated in ASCE/SEI-7 for all Designated Seismic Systems.
 - a. Provide equipment manufacturer's written certification for each designated active fire protection system seismic device and system, stating that it will remain operable following the design earthquake. Certification must be based on requirements of ASCE/SEI-7 and AHRI 1270, including shake table testing per ICC-ES AC156 or similar nationally recognized testing standard procedure acceptable to the AHJ.
 - b. Provide equipment manufacturer's written certification that components with hazard contents maintain containment following the design earthquake by methods required in ASCE/SEI-7.
- B. Operation and Maintenance Materials
 1. Operation and Maintenance Data: For air-spring mounts and restrained-air-spring mounts to include in operation and maintenance manuals.

1.06 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7 and that is acceptable to authorities having jurisdiction.
- B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
- C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are unavailable, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

1.07 COORDINATION

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

PART 2 PRODUCTS

2.01 ELASTOMERIC ISOLATION PADS

- A. Manufacturers:
 1. Ace Mountings Co., Inc.
 2. California Dynamics Corporation.
 3. Isolation Technology, Inc.
 4. Kinetics Noise Control, Inc.
 5. Mason Industries, Inc.
 6. Vibration Eliminator Co., Inc.
 7. Vibration Isolation.
 8. Vibration Mountings & Controls, Inc.
- B. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
- C. Size: Factory or field cut to match requirements of supported equipment.
- D. Pad Material: Oil and water resistant with elastomeric properties.
- E. Surface Pattern: Smooth pattern.

- F. Infused nonwoven cotton or synthetic fibers.
- G. Load-bearing metal plates adhered to pads.
- H. Sandwich-Core Material: Resilient and elastomeric.
 - 1. Surface Pattern: Smooth pattern.
 - 2. Infused nonwoven cotton or synthetic fibers.

2.02 ELASTOMERIC ISOLATION MOUNTS

- A. Double-Deflection, Elastomeric Isolation Mounts:
 - 1. Manufacturers:
 - a. California Dynamics Corporation.
 - b. Kinetics Noise Control, Inc.
 - c. Mason Industries, Inc.
 - d. Vibration Eliminator Co., Inc.
 - 2. Double-deflection type, with molded, oil-resistant rubber, hermetically sealed compressed fiberglass, or neoprene isolator elements with factory-drilled, encapsulated top plate for bolting to equipment and with baseplate for bolting to structure. Color-code or otherwise identify to indicate capacity range.
 - a. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
 - 3. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.

2.03 RESTRAINED ELASTOMERIC ISOLATION MOUNTS

- A. Manufacturers:
 - 1. Ace Mountings Co., Inc.
 - 2. California Dynamics Corporation.
 - 3. Isolation Technology, Inc.
 - 4. Kinetics Noise Control, Inc.
 - 5. Mason Industries, Inc.
 - 6. Vibration Eliminator Co., Inc.
 - 7. Vibration Isolation.
 - 8. Vibration Mountings & Controls, Inc.
- B. Description: All-directional isolator with seismic restraints containing two separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
- C. Housing: Cast-ductile iron or welded steel.
- D. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.04 OPEN-SPRING ISOLATORS

- A. Freestanding, Laterally Stable, Open-Spring Isolators:
 - 1. Manufacturers:
 - a. Ace Mountings Co., Inc.
 - b. California Dynamics Corporation.
 - c. Isolation Technology, Inc.
 - d. Kinetics Noise Control, Inc.
 - e. Mason Industries, Inc.
 - f. Vibration Eliminator Co., Inc.
 - g. Vibration Isolation.
 - h. Vibration Mountings & Controls, Inc.

2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Baseplates: Factory-drilled steel plate for bolting to structure with an elastomeric isolator pad attached to the underside. Baseplates shall limit floor load to 500 psig (3447 kPa).
7. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

2.05 HOUSED-SPRING ISOLATORS

- A. Freestanding, Laterally Stable, Open-Spring Isolators in Two-Part Telescoping Housing:
 1. Manufacturers:
 - a. Ace Mountings Co., Inc.
 - b. California Dynamics Corporation.
 - c. Isolation Technology, Inc.
 - d. Kinetics Noise Control, Inc.
 - e. Mason Industries, Inc.
 - f. Vibration Eliminator Co., Inc.
 - g. Vibration Isolation.
 - h. Vibration Mountings & Controls, Inc.
 2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 6. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators.
 - a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig (3447 kPa).
 - b. Top housing with attachment and leveling bolt.

2.06 RESTRAINED-SPRING ISOLATORS

- A. Freestanding, Laterally Stable, Open-Spring Isolators with Vertical-Limit Stop Restraint:
 1. Manufacturers:
 - a. Ace Mountings Co., Inc.
 - b. California Dynamics Corporation.
 - c. Isolation Technology, Inc.
 - d. Kinetics Noise Control, Inc.
 - e. Mason Industries, Inc.
 - f. Vibration Eliminator Co., Inc.
 - g. Vibration Isolation.
 - h. Vibration Mountings & Controls, Inc.
 2. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.
 - a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig (3447 kPa).
 - b. Top plate with threaded mounting holes.
 - c. Internal leveling bolt that acts as blocking during installation.
 3. Restraint: Limit stop as required for equipment and authorities having jurisdiction.

4. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
5. Minimum Additional Travel: 50 percent of the required deflection at rated load.
6. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
7. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.07 HOUSED-RESTRAINED-SPRING ISOLATORS

- A. Freestanding, Steel, Open-Spring Isolators with Vertical-Limit Stop Restraint in Two-Part Telescoping Housing:
 1. Manufacturers:
 - a. Ace Mountings Co., Inc.
 - b. California Dynamics Corporation.
 - c. Isolation Technology, Inc.
 - d. Kinetics Noise Control, Inc.
 - e. Mason Industries, Inc.
 - f. Vibration Eliminator Co., Inc.
 - g. Vibration Isolation.
 - h. Vibration Mountings & Controls, Inc.
 2. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators. Housings are equipped with adjustable snubbers to limit vertical movement.
 - a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig (3447 kPa).
 - b. Threaded top housing with adjustment bolt and cap screw to fasten and level equipment.
 3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.08 PIPE-RISER RESILIENT SUPPORTS

- A. Description: All-directional, acoustical pipe anchor consisting of two steel tubes separated by a minimum 1/2-inch- (13-mm-) thick neoprene.
 1. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.
 2. Maximum Load Per Support: 500 psig (3.45 MPa) on isolation material providing equal isolation in all directions.

2.09 RESILIENT PIPE GUIDES

- A. Description: Telescopic arrangement of two steel tubes or post and sleeve arrangement separated by a minimum 1/2-inch- (13-mm-) thick neoprene.
 1. Factory-Set Height Guide with Shear Pin: Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.10 AIR-SPRING ISOLATORS

- A. Freestanding, Single or Multiple, Compressed-Air Bellows: .
 1. Manufacturers:
 - a. Firestone Industrial Products Company.
 - b. Mason Industries, Inc.

2. Bellows Assembly: Upper and lower powder-coated steel sections connected by a replaceable, flexible, nylon-reinforced neoprene bellows or similar elastomeric material.
3. Maximum Natural Frequency: 3 Hz.
4. Operating Pressure Range: 25 to 100 psig (172 to 690 kPa).
5. Burst Pressure: At least three times manufacturer's published maximum operating pressure.
6. Tank valves.

2.11 RESTRAINED-AIR-SPRING ISOLATORS

- A. Freestanding, Single or Multiple, Compressed-Air Bellows with Vertical-Limit Stop Restraint: .
1. Manufacturers:
 - a. Firestone Industrial Products Company.
 - b. Mason Industries, Inc.
 2. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.
 - a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig (3447 kPa)).
 - b. Top plate with threaded mounting holes.
 - c. Internal leveling bolt that acts as blocking during installation.
 3. Restraint: Limit stop as required for equipment and authorities having jurisdiction.
 4. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 5. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 6. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 7. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 8. Bellows Assembly: Upper and lower powder-coated steel sections connected by a replaceable, flexible, nylon-reinforced neoprene bellows or similar elastomeric material.
 9. Maximum Natural Frequency: 3 Hz.
 10. Operating Pressure Range: 25 to 100 psig (172 to 690 kPa)a).
 11. Burst Pressure: At least three times manufacturer's published maximum operating pressure.
 12. Tank valves.

2.12 ELASTOMERIC HANGERS

- A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods: .
1. Manufacturers:
 - a. Ace Mountings Co., Inc.
 - b. California Dynamics Corporation.
 - c. Isolation Technology, Inc.
 - d. Kinetics Noise Control, Inc.
 - e. Mason Industries, Inc.
 - f. Vibration Eliminator Co., Inc.
 - g. Vibration Mountings & Controls, Inc.
 2. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
 3. Dampening Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.

2.13 SPRING HANGERS

- A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression:
 - 1. Manufacturers:
 - a. California Dynamics Corporation.
 - b. Kinetics Noise Control, Inc.
 - c. Mason Industries, Inc.
 - d. Vibration Eliminator Co., Inc.
 - 2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
 - 3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - 4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - 5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 - 6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 - 7. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
 - 8. Self-centering hanger-rod cap to ensure concentricity between hanger rod and support spring coil.
- B. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression with vertical limit stop:
 - 1. Manufacturers:
 - 2. California Dynamics Corporation.
 - a. Kinetics Noise Control, Inc.
 - b. Mason Industries, Inc.
 - c. Vibration Eliminator Co., Inc.
 - 3. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
 - 4. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - 5. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - 6. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 - 7. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 - 8. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
 - 9. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
 - 10. Self-centering hanger-rod cap to ensure concentricity between hanger rod and support spring coil

2.14 SNUBBERS

- A. Manufacturers:
 - 1. Kinetics Noise Control, Inc.
 - 2. Mason Industries, Inc.
 - 3. Vibration Mountings & Controls, Inc.
- B. Description: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.
 - 1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
 - 2. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.

3. Maximum 1/4-inch (6-mm) air gap, and minimum 1/4-inch (6-mm) thick resilient cushion.

2.15 SEISMIC EXPANSION LOOPS

- A. Manufacturers:
 1. Metraflex.
 2. Anvil International.
 3. Reliable Sprinkler Corporation.
- B. Description: Listed assembly of stainless-steel hose and braid with a 90-degree carbon steel elbow at each end and a 180-degree carbon steel return bend in the middle, allowing movement in all directions.
- C. Listing and Pressure Rating: Seismic expansion loops shall be UL Listed and FM Global approved for a working pressure of 300 psi (2070 kPa) for sizes up to and including NPS 6 (DN 150) and a working pressure of 175 psi (1200 kPa) for sizes NPS 8 (DN 200) and greater. Seismic expansion loops used on fire protection systems shall be specifically listed for use on fire protection systems.

2.16 RESTRAINT CHANNEL BRACINGS

- A. Manufacturers:
 1. Cooper B-Line, Inc.
 2. Hilti, Inc.
 3. Mason Industries, Inc.
 4. Unistrut.
- B. Description: MFMA-4, shop- or field-fabricated bracing assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.17 RESTRAINT CABLES

- A. Manufacturers:
 1. Kinetics Noise Control, Inc.
 2. Loos & Co., Inc.
 3. Vibration Mountings & Controls, Inc.
- B. Restraint Cables: ASTM A603 galvanized-steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; with a minimum of two clamping bolts for cable engagement.

2.18 SEISMIC-RESTRAINT ACCESSORIES

- A. Manufacturers:
 1. Cooper B-Line, Inc.
 2. Kinetics Noise Control, Inc.
 3. Mason Industries, Inc.
 4. TOLCO.
- B. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod.
- C. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings.
- D. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.
- E. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.

- F. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.19 MECHANICAL ANCHOR BOLTS

- A. Manufacturers:
 - 1. Cooper B-Line, Inc.
 - 2. Hilti, Inc.
 - 3. Kinetics Noise Control, Inc.
 - 4. Mason Industries, Inc.
- B. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488/E488M.

2.20 ADHESIVE ANCHOR BOLTS

- A. Manufacturers:
 - 1. Hilti, Inc.
 - 2. Kinetics Noise Control, Inc.
 - 3. Mason Industries, Inc.
- B. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488/E488M.

2.21 VIBRATION ISOLATION EQUIPMENT BASES

- A. Manufacturers:
 - 1. California Dynamics Corporation.
 - 2. Kinetics Noise Control.
 - 3. Mason Industries, Inc.
 - 4. Vibration Eliminator Co., Inc.
 - 5. Vibration Isolation.
 - 6. Vibration Mountings & Controls, Inc.
- B. Steel Rails: Factory-fabricated, welded, structural-steel rails.
 - 1. Design Requirements: Lowest possible mounting height with not less than 1-inch (25-mm) clearance above the floor. Include equipment anchor bolts and auxiliary motor slide rails.
 - a. Include supports for suction and discharge elbows for pumps.
 - 2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Rails shall have shape to accommodate supported equipment.
 - 3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
- C. Steel Bases: Factory-fabricated, welded, structural-steel bases and rails.
 - 1. Design Requirements: Lowest possible mounting height with not less than 1-inch (25-mm) clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
 - a. Include supports for suction and discharge elbows for pumps.
 - 2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Bases shall have shape to accommodate supported equipment.
 - 3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
- D. Concrete Inertia Base: Factory-fabricated, welded, structural-steel bases and rails ready for placement of cast-in-place concrete.

1. Design Requirements: Lowest possible mounting height with not less than 1-inch (25-mm) clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
 - a. Include supports for suction and discharge elbows for pumps.
2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Bases shall have shape to accommodate supported equipment.
3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
4. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

2.22 RESTRAINED ISOLATION ROOF-CURB RAILS

- A. Manufacturers:
 1. Ace Mountings Co., Inc.
 2. California Dynamics Corporation.
 3. Kinetics Noise Control.
 4. Mason Industries, Inc.
 5. Thybar Corporation.
- B. Description: Factory-assembled, fully enclosed, insulated, air- and watertight curb rail designed to resiliently support equipment and to withstand seismic and wind forces.
- C. Upper Frame: The upper frame shall provide continuous support for equipment and shall be captive to resiliently resist seismic and wind forces.
- D. Lower Support Assembly: The lower support assembly shall be formed sheet metal section containing adjustable and removable steel springs that support the upper frame. The lower support assembly shall have a means for attaching to building structure and a wood nailer for attaching roof materials, and shall be insulated with a minimum of 2 inches (50 mm) of rigid, glass-fiber insulation on inside of assembly. Adjustable, restrained-spring isolators shall be mounted on elastomeric vibration isolation pads and shall have access ports, for level adjustment, with removable waterproof covers at all isolator locations. Isolators shall be located so they are accessible for adjustment at any time during the life of the installation without interfering with the integrity of the roof.
- E. Snubber Bushings: All-directional, elastomeric snubber bushings at least 1/4 inch (6 mm) thick.
- F. Water Seal: Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past wood nailer of lower support assembly, and counterflashed over roof materials.

PART 3 EXECUTION

3.01 APPLICATION

- A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an evaluation service member of ICC-ES, OSHPD and/or an agency acceptable to authorities having jurisdiction.
- B. Hanger-Rod Stiffeners: Install hanger-rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.
- C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength is adequate to carry present and future static and seismic loads within specified loading limits

3.02 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation and seismic-and wind-control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.03 INSTALLATION

- A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Division 03 Section Cast-in-Place Concrete or "Miscellaneous Cast-in-Place Concrete."
- B. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.
- C. Comply with requirements in Division 07 Section "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.
- D. Equipment Restraints:
 - 1. Install seismic snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
 - 2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).
 - 3. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES, OSHPD and/or an agency acceptable to authorities having jurisdiction that provides required submittals for component
- E. Piping Restraints:
 - 1. Comply with requirements in MSS SP-127.
 - 2. Space lateral supports a maximum of 40 feet (12 m) o.c., and longitudinal supports a maximum of 80 feet (24 m) o.c.
 - 3. Brace a change of direction longer than 12 feet (3.7 m).
- F. Install cables so they do not bend across edges of adjacent equipment or building structure.
- G. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES that provides required submittals for component.
- H. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
- I. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- J. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- K. Drilled-in Anchors:
 - 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
 - 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
 - 3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
 - 4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole

- and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
 6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.
- L. Accommodation of Differential Seismic Motion
1. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Division 23 Section "Hydronic Piping" for piping flexible connections.
- M. Air-Spring Isolator Installation
1. Independent Isolator Installation:
 - a. Install tank valve into each air isolator.
 - b. Inflate each isolator to height and pressure specified on Drawings.
 2. Pressure-Regulated Isolator Installation:
 - a. Coordinate the constant pressure-regulated air supply to air springs with the requirements for piping and connections specified in Division 22 Section "General-Service Compressed-Air Piping."
 - b. Connect all pressure regulators to a single dry, filtered facility air supply.
 - c. Inflate isolators to height specified on Drawings.
- N. Vibration Isolation Equipment Base Installation
1. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Division 03 Section "Cast-in-Place Concrete."
- O. Installation of Fire Protection System Seismic Restraints
1. Install seismic restraints for fire protection and all other protection against earthquakes in accordance with all requirements of NFPA 13.
 2. Comply with installation requirements of NFPA 13 for all seismic-restraint devices.
 3. Seismic bracing and restraints installed on piping shall be installed such that the spray patten of the sprinklers in not obstructed.
 4. Design piping sway bracing in accordance with NFPA 13.
 - a. Maximum spacing of all sway bracing to be no greater than that indicated in NFPA 13 \.
 - b. Design loading of all sway bracing not to exceed values indicated in NFPA 13 3.

3.04 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Adjust active height of spring isolators.
- C. Adjust restraints to permit free movement of equipment within normal mode of operation.

3.05 ADJUSTING

- A. Adjust isolators after piping system is at operating weight.
- B. Adjust limit stops on restrained-spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

END OF SECTION

**SECTION 20 05 53
MECHANICAL IDENTIFICATION**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. General
 - 1. Manufacturers
- B. Equipment Labels.
 - 1. Metal Lables for Equipment
 - 2. Plastic Lables for Equipment
 - 3. Label Content
 - 4. Equipment Label Schedule
- C. Warning Signs and Labels
 - 1. Material and Thickness
 - 2. Letter Color
 - 3. Background Color
 - 4. Maximum Temperature
 - 5. Minimum Label Size
 - 6. Minimum Letter Size
 - 7. Fasteners
 - 8. Adhesive
 - 9. Label Content
- D. Pipe Labels
 - 1. General Requirements for Manufactured Pipe Labels
 - 2. Pretensioned Pipe Labels
 - 3. Self-Adhesive Pipe Labels
 - 4. Pipe Label Contents
- E. Duct Labels
 - 1. Material and Thickness
 - 2. Letter Color
 - 3. Background Color
 - 4. Maximum Temperature
 - 5. Minimum Label Size
 - 6. Minimum Letter Size
 - 7. Fasteners
 - 8. Adhesive
 - 9. Duct Label Contents
 - 10. All refrigeration piping shall be labeled at 30 foot intervals and in every separate area through which the piping passes. A permanent label shall be affixed, having a yellow background and black letters 1" high with the following wording
- F. Valve Tags
 - 1. Valve Tags
 - 2. Valve Schedules
- G. Warning Tags
 - 1. Warning Tags

1.02 GENERAL REFERENCES

- A. Contract Documents: Refer to complete set of Contract Documents for requirements that are related to or may affect the work described in this Section.

- B. Division 20, including all Common Mechanical Requirements in Section 20 00 00, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.

1.03 RELATED REQUIREMENTS

- A. Section 09 91 23 - Interior Painting: Identification painting. Section 21 05 00 – Common Work Results for Fire Protection, for identification for use on fire protection piping and equipment.
- B. Section 21 05 00 - Common Work Results For Fire-Protection, for identification for use on fire protection piping and equipment.

1.04 REFERENCE STANDARDS

- A. ASME A13.1 - Scheme for the Identification of Piping Systems; 2023.
- B. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2024.
- C. {RSTEMP#1883}

1.05 SUBMITTALS

- A. Action Submittals
 - 1. Product Data: For each type of product indicated.
 - 2. List: Submit list of wording, symbols, letter size, and color coding for mechanical identification.
 - 3. Chart and Schedule: Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
 - 4. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label
 - 5. Manufacturer's Installation Instructions: Indicate special procedures, and installation.
 - 6. Required Embodied Carbon Submittals: All products which satisfy one of the following criteria will require an Embodied Carbon Submittal:
 - a. The product is a 'Major' piece of equipment
 - b. The product contains refrigerant
 - c. The cost of a group of products serving a given function constitutes 5% or greater of the sub-contractor's budget, excluding labor.
 - 7. Embodied Carbon Submittals
 - a. Order of Preferred Submittals: For products which require an embodied carbon submittal (described above), one of the following must be provided. The submittal must be that with the highest preference available. The order preference, from highest to lowest is:
 - 1) Product Specific, Facility Specific EPD
 - 2) Product Specific EPD
 - 3) Industry Average EPD
 - 4) TM65 Manufacturer Form with Mid-Level Calculation data
 - 5) TM65 Manufacturer Form with Basic Calculation data
- B. Record Documents
 - 1. Record actual locations of tagged valves.

1.06 COORDINATION

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

PART 2 PRODUCTS

2.01 GENERAL

- A. Manufacturers
 - 1. Brady Co.
 - 2. Bramer.
 - 3. Craftmark.
 - 4. Emed.
 - 5. Marking Services, Inc.
 - a. Seton Name Plate Corp.

2.02 EQUIPMENT LABELS

- A. Metal Labels for Equipment:
 - 1. Material and Thickness: Brass, 0.032-inch (0.8-mm) minimum thickness, and having predrilled or stamped holes for attachment hardware.
 - 2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
 - 3. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 - 4. Fasteners: Stainless-steel self-tapping screws.
 - 5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Plastic Labels for Equipment:
 - 1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch (1.6 mm) thick, and having predrilled holes for attachment hardware.
 - 2. Letter Color: Black
 - 3. Background Color: Black
 - 4. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
 - 5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
 - 6. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 - 7. Fasteners: Stainless-steel self-tapping screws.
 - 8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.
- D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch (A4) bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.03 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch (3.2 mm) thick, and having predrilled holes for attachment hardware.
- B. Letter Color: Blue
- C. Background Color: Yellow
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
- E. Minimum Label Size: Length and width vary for required label content.
- F. Minimum Letter Size: 1 inch (25 mm).

- G. Fasteners: Stainless-steel rivets or self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.04 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
 - 2. Lettering Size: At least 1-1/2 inches (38 mm) high.

2.05 DUCT LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch (1.6 mm) thick, and having predrilled holes for attachment hardware.
- B. Letter Color: Black, unless specified otherwise in application schedule Blue
- C. Background Color: White, unless specified otherwise in application schedule Blue
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
- F. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- G. Fasteners: Stainless-steel self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings, duct size, and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions, or as separate unit on each duct label to indicate flow direction.
 - 2. Lettering Size: At least 1-1/2 inches (38 mm) high.
- J. All refrigeration piping shall be labeled at 30 foot intervals and in every separate area through which the piping passes. A permanent label shall be affixed, having a yellow background and black letters 1" high with the following wording:
 - 1. "HIGH PRESSURE REFRIGERANT – DANGER"
 - 2. "UN REFRIGERANTE DE ALTA PRESION – PELIGRO"

2.06 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4-inch (6.4-mm) letters for piping system abbreviation and 1/2-inch (13-mm) numbers.
 - 1. Tag Material: Brass 0.032 inch (0.8 mm) or stainless steel 0.025 inch (0.64 mm) minimum thickness, and having predrilled or stamped holes for attachment hardware.
 - 2. Fasteners: Brass beaded chain.

- B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch (A4) bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
1. Valve-tag schedule shall be included in operation and maintenance data.

2.07 WARNING TAGS

- A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
1. Size: 3 by 5-1/4 inches (75 by 133 mm) minimum .
 2. Fasteners: Brass grommet and wire.
 3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
 4. Color: Yellow background with black lettering.

PART 3 EXECUTION

3.01 PREPARATION

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

3.02 INSTALLATION

- A. General Installation Requirements:
1. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
 2. Coordinate installation of identifying devices with locations of access panels and doors.
 3. Install identifying devices before installing acoustical ceilings and similar concealment
- B. Equipment Labels
1. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
 2. Coordinate installation of identifying devices with locations of access panels and doors.
 3. Install identifying devices before installing acoustical ceilings and similar concealment.
 4. Install or permanently fasten labels on each major item of mechanical equipment.
 - a. Install metal labels on surfaces 125 degrees F and higher.
 - b. Install plastic labels on surfaces less than 125 degrees F.
 5. Locate equipment labels where accessible and visible.
 6. Do not penetrate vapor barriers with label fasteners
- C. Pipe Labels
1. Piping Color-Coding: Painting of piping is specified in Division 09 Section "Interior Painting
 2. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels with painted, color-coded bands or rectangles on each piping system.
 - a. Identification Paint: Use for contrasting background.
 - b. Stencil Paint: Use for pipe marking.
 3. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - a. Near each valve and control device.
 - b. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 - c. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.

- d. At access doors, manholes, and similar access points that permit view of concealed piping.
 - e. Near major equipment items and other points of origination and termination.
 - f. Spaced at maximum intervals of 50 feet (15 m) along each run. Reduce intervals to 25 feet (7.6 m) in areas of congested piping and equipment.
 - g. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
 - h. Do not penetrate vapor barriers with label fasteners.
 - i. Do not install plastic pipe labels on bare pipes conveying fluids at temperatures of 125 deg F or higher.
4. Pipe Label Color Schedule:
- a. Fire Protection:
 - 1) Background Color: Red.
 - 2) Letter Color: White.
 - b. Low-Pressure Compressed Air Piping:
 - 1) Background: Safety blue.
 - 2) Letter Colors: White.
 - c. Medium-Pressure Compressed Air Piping:
 - 1) Background: Safety blue.
 - 2) Letter Colors: White.
 - d. High Pressure Compressed Air Piping:
 - 1) Background: Safety blue.
 - 2) Letter Colors: White.
 - e. Domestic Water Piping:
 - 1) Background: Safety green.
 - 2) Letter Colors: White.
 - f. Sanitary Waste and Storm Drainage Piping:
 - 1) Background Color: Safety green.
 - 2) Letter Color: White
 - g. Chilled-Water Piping and Condenser Water Piping:
 - 1) Background Color: Green.
 - 2) Letter Color: White.
 - h. Heating Water Piping, Low-Pressure Steam Piping, High-Pressure Steam, Steam Condensate, Boiler Feed Water:
 - 1) Background Color: Yellow.
 - 2) Letter Color: Black.
 - i. Refrigerant Piping:
 - 1) Background Color: Yellow.
 - 2) Letter Color: Black.
 - j. Fuel Oil:
 - 1) Background Color: Yellow.
 - 2) Letter Color: Black.
 - k. Natural Gas:
 - 1) Background Color: Yellow.
 - 2) Letter Color: Black.
 - l. Compressed Air:
 - 1) Background Color: Blue.
 - 2) Letter Color: White
- D. Duct Labels
- 1. Install plastic-laminated duct labels with permanent adhesive on air ducts in the following color codes:
 - a. Blue: For cold-air supply ducts.

- b. Yellow: For hot-air supply ducts.
 - c. Green: For exhaust-, outside-, relief-, return-, and mixed-air ducts.
 - d. ASME A13.1 Colors and Designs: For hazardous material exhaust.
 - 2. Stenciled Duct Label Option: Stenciled labels, showing service and flow direction, may be provided instead of plastic-laminated duct labels, at Installer's option, if lettering larger than 1 inch (25 mm) high is needed for proper identification because of distance from normal location of required identification, and shall be provided where plastic or metal label fasteners would penetrate rated assembly or vapor barrier.
 - 3. Locate labels near points where ducts enter into concealed spaces and at maximum intervals of 50 feet (15 m) in each space where ducts are exposed or concealed by removable ceiling system.
 - 4. Locate labels to identify fire damper, smoke damper, combination fire/smoke damper, kitchen exhaust duct access in compliance with NFPA 90A and {RS#1883}.
- E. Valve Tags
- 1. For HVAC Systems: Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
 - 2. For Plumbing Systems: Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, faucets, convenience and lawn-watering hose connections, and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
 - 3. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
 - a. Valve-Tag Size and Shape: 2 inches (50 mm), round.
 - b. Valve-Tag Color:
 - 1) Fire Protection: Red.
 - 2) All Other Systems: Natural.
 - c. Letter Color:
 - 1) Fire Protection: White.
 - 2) All Other Systems: Black.
- F. Warning Tags
- 1. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION

**SECTION 20 07 00
MECHANICAL INSULATION**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Insulation Materials
 - 1. General
 - 2. Calcium Silicate - Type CS1H
 - 3. Calcium Silicate - Type CS2H
 - 4. Cellular Glass - Type CG1H
 - 5. Flexible Elastomeric Insulation - Type FEP and FE1H
 - 6. Glass Mineral Wool Preformed Pipe Insulation - Type F1P
 - 7. Glass Fiber Molded Pipe Insulation - Type F1H
 - 8. TYPE F2H - Not Used
 - 9. Glass Fiber Semi-Rigid Board Pipe and Tank Insulation - Type F3H
 - 10. Glass Mineral Wool Tank Insulation - Type F4P
 - 11. Glass Fiber Semi-Rigid Blanket Pipe And Tank Insulation - Type F4H (Faced), Type F4AH (Unfaced)
 - 12. Glass Fiber Rigid Board - Type F5H
 - 13. Glass Fiber Rigid Board – Elevated Temperature - Type F6H
 - 14. Glass Fiber Semi-Rigid Board-Elevated Temperature - Type F7H
 - 15. Type F8H - Not Used
 - 16. Glass Fiber Flexible Blanket - Type F9H
 - 17. Mineral Wool High-Temperature Pipe Insulation - Type MWH
 - 18. Mineral Wool Blanket Insulation - Type MWBLH
 - 19. High-Temperature, Mineral Wool Blanket Insulation - Type MWBLAH
 - 20. Mineral Wool Board Insulation - Type MWBH
 - 21. High-Temperature, Mineral Wool Board Insulation - Type MWBAH
 - 22. Mineral-Wool, Preformed Pipe Insulation - Type MWPH
 - 23. Mineral-Fiber, Pipe Insulation Wicking System
 - 24. Mineral-Fiber, Pipe and Tank Insulation - Type MWPTH
 - 25. Polyisocyanurate Insulation - Type PISOH
 - 26. Polyolefin - Type PP
- B. Fire-rated Insulation Systems
 - 1. Fire-Rated Board - Type FRB1H
 - 2. Fire-Rated Insulation Blanket - Type FRB2H
 - 3. Removable Blanket Insulation Systems for Engine and Generator Exhaust Components
- C. Insulating Cements
 - 1. Mineral-Fiber Insulating Cement
 - 2. Expanded or Exfoliated Vermiculite Insulating Cement
 - 3. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement
- D. Adhesives
 - 1. Adhesives, mastics, insulating cements, lagging adhesives, and sealants shall be compatible with insulation materials, jackets, and substrates to which applied, and suitable for operating temperatures of equipment, piping and duct systems.
 - 2. Calcium Silicate Adhesive
 - 3. Cellular-Glass Adhesive
 - 4. Phenolic and Polyisocyanurate Adhesive
 - 5. Flexible Elastomeric and Polyolefin Adhesive
 - 6. Mineral-Fiber Adhesive

7. ASJ Adhesive, and FSK and PVDC Jacket Adhesive
8. PVC Jacket Adhesive
- E. Mastics
 1. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II
 2. Vapor-Barrier Mastic
 3. Vapor-Barrier Mastic
 4. Vapor-Barrier Mastic
 5. Breather Mastic
- F. Lagging Adhesives
 1. Description
- G. Sealants
 1. Joint Sealants
 2. FSK and Metal Jacket Flashing Sealants
 3. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants
- H. Factory-Applied Jackets
 1. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following
- I. Field-Applied Jackets
 1. Field-applied jackets shall comply with ASTM C921, Type I, unless otherwise indicated.
 2. PVC Jacket - Type J7
 3. Metal Jackets
 4. Self-Adhesive Outdoor Jacket - Type J10
 5. PVDC Jacket for Indoor and Outdoor Applications - Type J4 (Same as Factory Applied)
 6. Underground Direct-Buried Jacket - Type J11
- J. Removable, Re-Usable Insulating Jackets
 1. Custom factory fabricated, close-fitting contoured insulating jacket to fully cover equipment including flange connections to adjacent piping. Jackets shall be capable of removal and reinstallation without modification. Insulation material and thickness shall be sufficient to maintain an outer jacket surface temperature of 100 degrees F or less.
 2. Field-Applied Fabric-Reinforcing Mesh
 3. Field-Applied Cloths
- K. Tapes
 1. ASJ Tape
 2. FSK Tape
 3. PVC Tape
 4. Aluminum-Foil Tape
 5. PVDC Tape for Indoor and Outdoor Applications
- L. Securements
 1. Bands
 2. Insulation Pins and Hangers
 3. Staples
 4. Wire
- M. Corner Angles
 1. PVC Corner Angles
 2. Aluminum Corner Angles
 3. Stainless-Steel Corner Angles
- N. Undersink ADA Protective Shielding Guards
 1. Protective Shielding Pipe Covers

2. Protective Shielding Piping Enclosures

1.02 REFERENCE STANDARDS

- A. 40 CFR 59, Subpart D - National Volatile Organic Compound Emission Standards for Architectural Coatings; U.S. Environmental Protection Agency; Current Edition.
- B. ASTM A167 - Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip; Latest Edition.
- C. ASTM A240/A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications; 2025a.
- D. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2021a.
- E. ASTM C165 - Standard Test Method for Measuring Compressive Properties of Thermal Insulations; 2023.
- F. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus; 2019, with Editorial Revision (2023).
- G. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement; 2007 (Reapproved 2024).
- H. ASTM C196 - Standard Specification for Expanded or Exfoliated Vermiculite Thermal Insulating Cement; Approved Edition.
- I. ASTM C411 - Hot-Surface Performance of High Temperature Thermal Insulation; x.
- J. ASTM C449 - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement; 2007 (Reapproved 2024).
- K. ASTM C450 - Standard Practice for Fabrication of Thermal Insulating Fitting Covers for NPS Piping, and Vessel Lagging; 2018.
- L. ASTM C533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation; 2017 (Reapproved 2023).
- M. ASTM C499 - Standard Test Method for Facial Dimensions and Thickness of Flat, Rectangular Ceramic Wall and Floor Tile; 2020.
- N. ASTM C516 - Standard Specification for Vermiculite Loose Fill Thermal Insulation; 2019.
- O. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 2021.
- P. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form; 2025.
- Q. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation; 2022a.
- R. ASTM C552 - Standard Specification for Cellular Glass Thermal Insulation; 2022.
- S. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications; 2024.
- T. ASTM C578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation; 2023.
- U. ASTM C585 - Standard Practice for Inner and Outer Diameters of Thermal Insulation for Nominal Sizes of Pipe and Tubing; 2022.
- V. ASTM C591 - Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation; 2022.
- W. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation; 2014 (Reapproved 2019).

- X. ASTM C656 - Standard Specification for Structural Insulating Board, Calcium Silicate; 2017 (Reapproved 2023).
- Y. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel; 2008 (Reapproved 2023).
- Z. ASTM C871 - Standard Test Methods for Chemical Analysis of Thermal Insulation Materials for Leachable Chloride, Fluoride, Silicate, and Sodium Ions; Approved Edition.
- AA. ASTM C921 - Standard Specification for Jackets for Thermal Insulation; Approved Edition.
- BB. ASTM C1126 - Standard Specification for Faced or Unfaced Rigid Cellular Phenolic Thermal Insulation; 2019.
- CC. ASTM C1136 - Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation; 2023.
- DD. ASTM C1290 - Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts; 2016 (Reapproved 2021).
- EE. ASTM C1393 - Standard Specification for Perpendicularly Oriented Mineral Fiber Roll and Sheet Thermal Insulation for Pipes; x.
- FF. ASTM C1427 - Standard Specification for Extruded Preformed Flexible Cellular Polyolefin Thermal Insulation in Sheet and Tubular Form; 2021.
- GG. ASTM D1644 - Standard Specification for Resilient Connectors Between Reinforced Concrete On-Site Wastewater Tanks and Pipes; Approved Edition.
- HH. ASTM D1784 - Standard Classification System and Basis for Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds; 2020.
- II. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2024.
- JJ. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2024a.
- KK. ASTM F1249 - Standard Test Method for Water Vapor Transmission Rate Through Plastic Film and Sheeting Using a Modulated Infrared Sensor; 2020.
- LL. ICC A117.1 - Accessible and Usable Buildings and Facilities; 2017.
- MM. MIL-A-3316C - ADHESIVES, FIRE-RESISTANT, THERMAL INSULATION; Approved Edition.
- NN. MIL-A-24179 - Adhesive, Flexible Unicellular-Plastic Thermal Insulation; 1969a (Validated 2020).
- OO. MIL-C-19565C - COATING COMPOUNDS, THERMAL INSULATION, FIRE- AND WATER-RESISTANT, VAPOR-BARRIER; Approved Edition.
- PP. MIL-C-20079H - CLOTH, GLASS; TAPE, TEXTILE GLASS; AND THREAD, GLASS AND WIRE-REINFORCED GLASS; x.
- QQ. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2024.
- RR. {RSTEMP#undefined}

1.03 ABBREVIATIONS AND ACRONYMS

- A. AHJ: Authorities Having Jurisdiction.
- B. ASJ: All Service Jacket (no outer film).
- C. ASJ: All Service Jacket.
- D. ASJ+: All Service Jacket composed of aluminum foil reinforced with glass scrim bonded to a kraft paper interleaving with an outer film layer leaving no paper exposed.
- E. ASJ-SSL: All Service Jacket with Self Sealing Lap Closure.

- F. ASTM: American Society for Testing and Materials.
- G. CFC: Chlorofluorocarbons.
- H. CFR: Code of Federal Regulations.
- I. EPA: Environmental Protection Agency.
- J. FSK: Foil Scrim Kraft.
- K. FSK: Foil Scrim Kraft; jacketing.
- L. HCFC: Hydrochlorofluorocarbons.
- M. NFPA: National Fire Protection Association.
- N. NPS: Nominal Pipe Size.
- O. NRTL: Nationally Recognized Testing Laboratory.
- P. PPM: Parts per Million.
- Q. PSK: Poly Scrim Kraft; jacketing.
- R. PVC: Polyvinyl Chloride.
- S. PVDC: Polyvinylidene Chloride.
- T. SSL: Self-Sealing Lap.
- U. SSL+: Self-Sealing Lap with Advanced Closure System.
- V. UV: Ultraviolet.
- W. VOC: Volatile Organic Compounds.
- X. WHO: World Health Organization.

1.04 DEFINITIONS

- A. Thermal Conductivity (K value): Units of Btu-inch/hour per square foot per degree F.
- B. UL GREENGUARD: Provides independent third-party, Indoor Air Quality (IAQ) certification of products for emissions of respirable particles and Volatile Organic Compounds (VOC's), including formaldehyde and other specific product-related pollutants. Certification is based upon criteria used by EPA, OSHA, and WHO.
- C. UL GREENGUARD Gold Certification: (formerly known as GREENGUARD Children & Schools Certification) offers stricter certification criteria, considers safety factors to account for sensitive individuals (such as children and the elderly), and ensures that a product is acceptable for use in environments such as schools and healthcare facilities. It is referenced by both The Collaborative for High Performance Schools (CHPS) and the Leadership in Energy Environmental Design (LEED) Building Rating Systems

1.05 SUBMITTALS

- A. Action Submittals
 - 1. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).
 - 2. Shop Drawings:
 - a. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - b. Detail attachment and covering of heat tracing inside insulation.
 - c. Detail insulation application at pipe expansion joints for each type of insulation.
 - d. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
 - e. Detail removable insulation at piping specialties, equipment connections, and access panels.
 - f. Detail application of field-applied jackets.

- g. Detail application at linkages of control devices.
 - h. Detail field application for each equipment type.
 - 3. Required Embodied Carbon Submittals: All products which satisfy one of the following criteria will require an Embodied Carbon Submittal:
 - a. The product is a 'Major' piece of equipment
 - b. The product contains refrigerant
 - c. The cost of a group of products serving a given function constitutes 5% or greater of the sub-contractor's budget, excluding labor.
 - 4. Embodied Carbon Submittals
 - a. Order of Preferred Submittals: For products which require an embodied carbon submittal (described above), one of the following must be provided. The submittal must be that with the highest preference available. The order preference, from highest to lowest is:
 - 1) Product Specific, Facility Specific EPD
 - 2) Product Specific EPD
 - 3) Industry Average EPD
 - 4) TM65 Manufacturer Form with Mid-Level Calculation data
 - 5) TM65 Manufacturer Form with Basic Calculation data
- B. Informational Submittals
 - 1. Qualification Data: For qualified installer.
 - 2. Field quality control reports.
- C. Operation and Maintenance Materials
 - 1. Include manufacturer's descriptive literature, cleaning procedures, and maintenance and repair data.
- D. Record Documents
 - 1. Record as-built drawings.
 - 2. Record digital files.
 - a. Digital layout models.
 - b. Product data.
 - c. Final submittals with Responses.

1.06 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
 - 1. Furnish services of installers who have successfully completed manufacturer's installation training. Submit qualification data for manufacturer-trained mechanics.
- B. Inspection: Furnish inspection of installed mechanical insulation performed by inspectors who maintain current certification by National Insulation Association or other certified mechanical association. Inspect complete insulation installation to verify that materials and total insulation system has been installed in accordance with contract documents and material manufacturer's written instructions.
- C. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

- D. Comply with the following applicable standards and other requirements specified for miscellaneous components:
1. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.07 PRE-INSTALLATION TESTING

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

1.08 MOCK-UPS AND SAMPLES

- A. Mockups: Before installing insulation, build mockups for each type of insulation and finish listed below to demonstrate quality of insulation application and finishes. Build mockups in the location indicated or, if not indicated, as directed by Architect. Use materials indicated for the completed Work.
1. Plumbing Piping Mockups:
 - a. One 10-foot section of NPS 2 straight pipe.
 - b. One each of a 90-degree threaded, welded, and flanged elbow.
 - c. One NPS 2 or smaller valve, and one NPS 2-1/2 or larger valve.
 - d. One each of a threaded, welded, and flanged tee fitting.
 - e. Four support hangers including hanger shield and insert.
 - f. One threaded strainer and one flanged strainer with removable portion of insulation.
 - g. One threaded reducer and one welded reducer.
 - h. One pressure temperature tap.
 - i. One mechanical coupling.
 2. HVAC Piping Mockups:
 - a. Fabricate a pipe assembly of 1" carbon steel pipe with an elbow, a tee, a ball valve with extended insulation handle, a union, all in line, each separated by a 6 inch long nipple. Provide a 6 inch long nipple on the end of the elbow, and a 6 inch long nipple and pipe cap on the branch leg of the tee.
 - b. At one nipple, provide hanger shield and insert.
 3. Ductwork Mockups:
 - a. One 4-foot section of 12"x12" straight duct, capped at one end.
 4. Equipment Mockups:
 - a. One chilled water pump and one heating hot water pump
 - b. One hot tank and one cold tank.
 - c. One shell and tube heat exchanger.
 - d. One plate and frame heat exchanger
 5. For each mockup, fabricate cutaway sections to allow observation of application details for insulation materials, adhesives, mastics, attachments, and jackets.
 6. Notify Architect seven days in advance of dates and times when mockups will be constructed.
 7. Obtain Architect's approval of mockups before starting insulation application.
 8. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 9. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 10. Demolish and remove mockups when directed
- B. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use. Sample sizes are as follows:
1. Preformed Pipe Insulation Materials: 12 inches long by NPS 2.
 2. Jacket Materials for Pipe: 12 inches long by NPS 2.

3. Sheet Jacket Materials: 12 inches square.
4. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

1.09 COORDINATION

- A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 20 Section "Hangers and Supports."
- B. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

1.10 DELIVERY, STORAGE AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.
- B. Store tapes, adhesives, mastics, cements and insulation materials in ambient conditions in accordance with the recommendation of the manufacturer.
- C. Protect insulation against dirt, water, chemical and mechanical damage before, during and after installation. Do not install damaged insulation and remove it from the project site. Insulation that has become wet shall be considered damaged and replacement is required.

1.11 SUMMARY DESCRIPTION

- A. Section includes insulating the following fire protection services:
 1. Engine coolant piping for remote radiator of engine-driven fire pump.
 2. Engine exhaust piping and silencer.
 3. Indoor and outdoor equipment.
 4. Indoor and outdoor piping
- B. Section includes insulating the following plumbing services:
 1. Domestic cold-water piping.
 2. Domestic hot-water piping.
 3. Domestic recirculating hot-water piping.
 4. Domestic chilled-water piping for drinking fountains.
 5. Sanitary waste piping exposed to freezing conditions.
 6. Storm-water piping exposed to freezing conditions.
 7. Roof drains and rainwater leaders.
 8. Supplies and drains for handicap-accessible lavatories and sinks
- C. Section includes insulating the following HVAC services:
 1. Piping insulation, jacketing and accessories
 2. Equipment insulation and jacketing
 3. Ductwork insulation and jacketing

PART 2 PRODUCTS

2.01 INSULATION MATERIALS

- A. General
 1. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.
 2. Products shall not contain formaldehyde, asbestos, lead, mercury, or mercury compounds.
 3. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C795.

4. Glass mineral wool product shall contain a minimum 50% recycled content.
 5. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C871.
 6. Insulation materials shall be fire retardant, moisture and mildew resistant, vermin proof, and suitable to receive jackets, adhesives and coatings as indicated.
 7. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
 8. Glass mineral wool bonded with a bio-based thermosetting resin. Insulation shall be of inert inorganic material, non-corrosive to mechanical surfaces.
- B. Calcium Silicate - Type CS1H:
1. Manufacturers:
 - a. Industrial Insulation Group (The); Thermo-12 Gold.
 2. Preformed Pipe insulation in flat, curved and grooved block sections of noncombustible, inorganic, hydrous calcium silicate with a con-asbestos reinforcement, complying with ASTM C533, Type II. Prefabricated Fitting insulation complying with ASTM C450 and ASTM C585 for dimensions used in preforming insulation to cover valves, elbows, tees and flanges.
 3. K" Value: 0.45 at 200 deg F mean temperature.
 4. Maximum Service Temperature: 1200 deg F
 5. Hydraulic Setting Insulation and finishing cement complying with ASTM C499.
 6. Lagging adhesive complying with MIL-A-33316C, Class I, Grade A.
 7. Woven Glass-Fiber Fabric complying with Mill-C-20079H, Type I, plain weave and presized, minimum 8 oz./sq.yd
- C. Calcium Silicate - Type CS2H:
1. Manufacturers:
 - a. IIG Insulation Systems: Super Caltemp Gold 1700.
 2. Preformed Pipe insulation in flat, curved and grooved block sections of noncombustible, inorganic, hydrous calcium silicate with a con-asbestos reinforcement, complying with ASTM C533, Type II. Prefabricated Fitting insulation complying with ASTM C450 and ASTM C585 for dimensions used in preforming insulation to cover valves, elbows, tees and flanges.
 3. "K" Value: 0.54 at 200 deg F mean temperature.
 4. Maximum Service Temperature: 1700 deg F
 5. Hydraulic Setting Insulation and finishing cement complying with ASTM C499.
 6. Lagging adhesive complying with MIL-A-33316C, Class I, Grade A.
 7. Woven Glass-Fiber Fabric complying with Mill-C-20079H, Type I, plain weave and presized, minimum 8 oz./sq.yd.
- D. Cellular Glass - Type CG1H:
1. Manufacturers:
 - a. Pittsburgh Corning Corporation
 - b. Foamglas
 2. Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 3. Block Insulation: ASTM C552, Type I.
 4. Special-Shaped Insulation: ASTM C552, Type III.
 5. Board Insulation: ASTM C552, Type IV.
 6. Preformed Pipe Insulation without Jacket: Comply with ASTM C552, Type II, Class 1.
 7. Preformed Pipe Insulation with Factory-Applied ASJ: Comply with ASTM C552, Type II, Class 2.
 8. Factory fabricate shapes according to ASTM C450 and ASTM C585.

- E. Flexible Elastomeric Insulation - Type FEP and FE1H:
 - 1. Manufacturers:
 - a. Aramacell LLC: ArmaFlex Ultra.
 - b. Aeroflex USA, Inc.
 - c. K-Flex
 - 2. Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C534/C534M, Type I for tubular materials and Type II for sheet materials. Average thermal conductivity of 0.28 BTU/Hr/Sq.Ft/Deg. F at 75 degrees mean temperature per inch thickness. Comply with UL 723 Listed and labeled for flame spread/smoke developed ratings of 25/50.
- F. Flexible Elastomeric Sheet Insulation - Type FE2H:
 - 1. Manufacturers:
 - a. Aeroflex USA: Aerocel
 - b. Armacel: AP Armaflex.
 - c. K-Flex USA: Insul-Lock, Insul-Tube, K-Flex LS
 - 2. Flexible elastomeric sheet insulation with self-adhering backing in sheets and rolls.
 - a. "K" Value: ASTM C177 or ASTM C518, 0.27 at 73 deg F mean temperature.
 - b. Service Temperature limits: -70 deg F to 180 deg F
 - c. Water Vapor Permeability: 0.08 perm-in.
 - d. Water Absorption: 0.2% by volume.
 - e. Flame and smoke rating: Through 1-inch thickness: 25/50.
 - f. Ozone Resistance: Good
- G. Glass Mineral Wool Preformed Pipe Insulation - Type F1P:
 - 1. Manufacturers:
 - a. Johns Manville; a Berkshire Hathaway company.
 - b. Knauf Insulation.
 - c. Manson Insulation Inc.
 - d. Owens Corning
 - 2. Glass mineral wool bonded with a bio-based thermosetting resin. Type I, 850 Deg F or Type IV 1000 Deg F. Comply with ASTM C585, ASTM C411, ASTM C795, and ASTM C547, Type I, and Type IV, with factory-applied ASJ+-SSL. UL Environment verified to be formaldehyde free. Pipe insulation to have a validated EPD by UL Environment. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article. Average thermal conductivity of 0.24 BTU/Hr/Sq.Ft/Deg. F at 100 degrees mean temperature per inch thickness.
- H. Glass Fiber Molded Pipe Insulation - Type F1H:
 - 1. Manufacturers:
 - a. Knauf Insulation: Earthwool with ASJ+ with SSL.
 - b. Johns-Manville: Micro Lok with ASJ with SSL
 - c. Owens Corning: Fiberglass with ASJ-Max with SSL
 - 2. Glass Fiber: FHC 25/50 per ASTM E 84; ASTM C547 Type IV, Grade A, ASTM C585, ASTM C411 and ASTM C795.
 - a. "K" Value: ASTM C335, 0.23 at 75 deg F mean temperature.
 - b. Maximum Service Temperature: 850 deg
 - c. Vapor retarder Jacket: ASJ + SSL conforming to ASTM C1146 Type I, secured with self-sealing longitudinal laps and matching butt strips.
- I. TYPE F2H - Not Used
- J. Glass Fiber Semi-Rigid Board Pipe and Tank Insulation - Type F3H:
 - 1. Manufacturers:
 - a. Knauf Insulation: Pipe and Tank Insulation with ASJ+.
 - b. Johns-Manville: Fabrication board with ASJ

- c. Owens Corning: Fiberglass Pipe and Tank Insulation
- 2. Glass Fiber: FHC 25/50 per ASTM E84; ASTM C1393 and ASTM C795.
 - a. "K" Value: ASTM C335, 0.25 at 75 deg F mean temperature.
 - b. Maximum Service Temperature: 850 deg F
 - c. Compressive Strength: Not less than 120 PSF at 10% deformation per ASTM C165
 - d. Vapor retarder Jacket: ASJ conforming to ASTM C1146 Type II
- K. Glass Mineral Wool Tank Insulation - Type F4P:
 - 1. Manufacturers:
 - a. Johns Manville; a Berkshire Hathaway company.
 - b. Knauf Insulation.
 - c. Manson Insulation Inc.
 - d. Owens Corning.
 - 2. Glass mineral wool bonded with a bio-based thermosetting resin. Nominal density is 2.5 lb/cu. ft. (40 kg/cu. m) or more. Thermal conductivity (k-value) at 100 deg F is 0.269 Btu x in./h x sq. ft. x deg F or less. Semi-rigid board material with factory-applied ASJ complying with ASTM C1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C612, Type IB. UL Environment Verified to be formaldehyde free. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
- L. Glass Fiber Semi-Rigid Blanket Pipe And Tank Insulation - Type F4H (Faced), Type F4AH (Unfaced):
 - 1. Manufacturers:
 - a. Johns-Manville: Micro Flex
 - b. Owens Corning: Flexwrap
 - 2. Glass Fiber: Semi-rigid fiber glass blanket in roll form meeting requirements of UL 723, ASTM C1393, ASTM C447 and ASTM C356.
 - a. "K" Value: ASTM C516, 0.24 at 75 deg F mean temperature.
 - b. Maximum Service Temperature: 850 for faced product
 - c. Compressive strength: Not less than 25 PSF at 10% deformation per ASTM C165.
 - d. Vapor retarder Jacket: ASJ conforming to ASTM C1136
- M. Glass Fiber Rigid Board - Type F5H:
 - 1. Manufacturers:
 - a. Knauf Insulation: Insulation Board.
 - b. Johns-Manville: 800 Spin-glas
 - c. Owens Corning: 700 Series Fiberglas™.
 - 2. Rigid fiber Glass Board, ASTM C612, Type 1A and 1B, FHC 25/50 per ASTM E84.
 - a. Maximum Service Temperature: 450 deg F.
 - b. Concealed Areas:
 - 1) Density: Minimum 3 PCF.
 - 2) "K" Value: ASTM C177, 0.23 at 75 deg F mean temperature
 - 3) Vapor Retarder Jacket: FSK conforming to ASTM C1136, Type II.
 - c. Exposed to view Areas:
 - 1) Density: Minimum 6 PCF
 - 2) "K" Value: ASTM C 177, 0.22 at 75 deg F mean temperature.
 - 3) Vapor Retarder Jacket: See Section 3.17 Duct and Plenum Insulation Schedule
- N. Glass Fiber Rigid Board – Elevated Temperature - Type F6H:
 - 1. Manufacturers:
 - a. Knauf Insulation: Elevated Temperature Board
 - b. Johns-Manville: 1000-Series Spin-glas
 - c. Owens Corning: Fiberglas SCR
 - 2. Rigid Fiber Glass Board: ASTM C612 Type IA, IB and II, rigid, noncombustible and ASTM C447.

- a. "K" Value: ASTM C177, 0.25 at 100 deg F mean temperature.
 - b. Density: 2.8 PCF
 - c. Maximum Service Temperature: 850 deg F
 - d. Unfaced.
- O. Glass Fiber Semi-Rigid Board-Elevated Temperature - Type F7H:
 - 1. Manufacturers:
 - a. Knauf Insulation: Elevated Temperature Panel.
 - b. Johns-Manville: Precipitator Spin-glas
 - c. Owens Corning: Fiberglass TIW, Type II
 - 2. Semi-Rigid fiber Glass Board: ASTM C612 Type II and III; semi-rigid, non-combustible and ASTM C 447.
 - a. "K" Value: ASTM C177, 0.25 at 100 deg F mean temperature.
 - b. Maximum Service Temperature: 850 deg F
 - c. Density: 2/4 PCF
 - d. Unfaced.
- P. Type F8H - Not Used
- Q. Glass Fiber Flexible Blanket - Type F9H:
 - 1. Manufacturers:
 - a. Knauf Insulation: Friendly Feel Duct Wrap.
 - b. Johns-Manville: Micro Lite XG
 - c. Owens Corning: Duct Wrap
 - 2. Flexible Fiber Glass Blanket: ASTM C553 Type I, II and III, and ASTM C1290; FHC 25/50 per ASTM E 84.
 - a. "K" Value: ASTM C177, 0.29 at 75 deg F mean temperature.
 - b. Maximum Service Temperature: Faced: 250 deg F Unfaced: 350 deg F
 - c. Factory-applied vapor retarder jacket: Type J1, J2 or J5. See Section 3.17 Duct and Plenum Insulation Schedule.
 - d. Installation: Maximum allowable compression: 25%
 - e. Density:
 - 1) Concealed areas: Minimum 0.75 PCF
 - 2) Exposed to view areas: Minimum 1.0 PCF.
 - 3) Exposed to view in Mechanical Rooms: Minimum 1.5 PCF.
- R. Mineral Wool High-Temperature Pipe Insulation - Type MWH:
 - 1. Manufacturers:
 - a. Johns Manville – Minwool-1200 Pipe
 - b. IIG
 - 2. Specification Compliance:
 - a. "K" Value: 0.30 at 200 deg F mean temperature.
 - b. Maximum Service Temperature: 1200 deg F
 - c. Linear Shrinkage after 24 hours at 1200 deg F: Less than 2%
 - d. Comply with ASTM E84 – Flame spread: 5 and Smoke developed: 0
- S. Mineral Wool Blanket Insulation - Type MWBLH:
 - 1. Manufacturers:
 - a. CertainTeed Corp.; SoftTouch Duct Wrap.
 - b. Johns Manville; Microlite.
 - c. Knauf Insulation; Atmosphere Duct Wrap.
 - d. Manson Insulation Inc.; Alley Wrap.
 - e. Owens Corning; SOFTR All-Service Duct Wrap

2. Mineral fibers bonded with a thermosetting resin. Comply with ASTM C553, Type II and ASTM C1290, Type I. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
- T. High-Temperature, Mineral Wool Blanket Insulation - Type MWBLAH:
 1. Manufacturers:
 - a. Industrial Insulation Group (IIG); MinWool-1200 Flexible Batt.
 - b. Johns Manville; HTB 26 Spin-Glas.
 - c. Roxul Inc.; Roxul RW
 2. Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C533, Type V, without factory-applied jacket.
- U. Mineral Wool Board Insulation - Type MWBH:
 1. Manufacturers:
 - a. CertainTeed Corp.; CertaPro Commercial Board.
 - b. Fibrex Insulations Inc.; FBX.
 - c. Johns Manville; 800 Series Spin-Glas.
 - d. Knauf Insulation; Earthwool Insulation Board.
 - e. Manson Insulation Inc.; AK Board.
 - f. Owens Corning; Fiberglas 700 Series
 2. Mineral fibers bonded with a thermosetting resin. Comply with ASTM C612, Type IA or Type IB. For duct and plenum applications, provide insulation without factory-applied jacket. For equipment applications, provide insulation without factory-applied jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
- V. High-Temperature, Mineral Wool Board Insulation - Type MWBAH:
 1. Manufacturers:
 - a. Fibrex Insulations Inc.; FBX. Industrial Insulation Group (IIG); MinWool-1200 Industrial Board.
 - b. Rock Wool; Delta Board.
 - c. Roxul Inc.; RHT and RockBoard.
 - d. Thermafiber, Inc.; Thermafiber Industrial Felt
 2. Mineral fibers bonded with a thermosetting resin. Comply with ASTM C612, Type III, without factory-applied jacket.
- W. Mineral-Wool, Preformed Pipe Insulation - Type MWPH:
 1. Manufacturers:
 - a. Fibrex Insulations Inc.; Coreplus 1200.
 - b. Johns Manville; Micro-Lok.
 - c. Knauf Insulation; Earthwool 1000° Pipe Insulation.
 - d. Manson Insulation Inc.; Alley-K.
 - e. Owens Corning; Fiberglas Pipe Insulation.
 2. Type I, 850 deg F (454 deg C) Materials: Mineral fibers bonded with a thermosetting resin. Comply with ASTM C547, Type I, Grade A, without factory-applied jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 3. Type II, 1200 deg F (649 deg C) Materials: Mineral fibers bonded with a thermosetting resin. Comply with ASTM C547, Type II, Grade A, without factory-applied jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
- X. Mineral-Fiber, Pipe Insulation Wicking System:
 1. Manufacturers:
 - a. Knauf Insulation; Permawick Pipe Insulation.
 - b. Owens Corning; VaporWick Pipe Insulation.
 2. Preformed pipe insulation complying with ASTM C547, Type I, Grade A, with absorbent cloth factory applied to the entire inside surface of preformed pipe insulation and extended through the longitudinal joint to outside surface of insulation under insulation jacket.

Factory apply a white, polymer, vapor-retarder jacket with self-sealing adhesive tape seam and evaporation holes running continuously along the longitudinal seam, exposing the absorbent cloth.

- Y. Mineral-Fiber, Pipe and Tank Insulation - Type MWPTH:
 - 1. Manufacturers:
 - a. CertainTeed Corp.; CrimpWrap.
 - b. Johns Manville; MicroFlex.
 - c. Knauf Insulation; Earthwool Pipe & Tank Insulation.
 - d. Manson Insulation Inc.; AK Flex.
 - e. Owens Corning; Fiberglas Pipe and Tank Insulation.
 - 2. Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ complying with ASTM C1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C612, Type IB. Nominal density is 2.5 lb./cu. ft (40 kg/cu. m) or more. Thermal conductivity (k-value) at 100 deg F (55 deg C) is 0.29 Btu x in./h x sq. ft. x deg F (0.042 W/m x K) or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
- Z. Polyisocyanurate Insulation - Type PISOH:
 - 1. Manufacturers:
 - a. Dyplast Products: ISO-C1
 - b. Johns Manville: Trymer 25-50.
 - 2. Preformed, rigid polyisocyanurate pipe insulation with PVDC jacket: ASTM C591, Grade 2, Type III, fabricated in shapes according to ASTM C450 and ASTM C585.
 - a. "K" Value: Shall not exceed 0.19 at 75 deg F after 180 days aging.
 - b. Maximum Service Temperature: 300 deg F
 - c. Flame-spread index shall be 25 or less, and smoke-developed index shall be 50 or less for thickness up to 1 inch as tested by ASTM E84.
 - d. Vapor barrier Jacket: 6-mil thick PVDC-SSL factory applied jacket with 0.01 perm in accordance with ASTM E96/E96M, self-sealing, pressure sensitive seams
- AA. Polyolefin - Type PP:
 - 1. Manufacturers:
 - a. Armacell LLC.
 - b. K-flex USA
 - 2. Polyolefin: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C534/C534M or ASTM C1427, Type I, Grade 1 for tubular materials and Type II, Grade 1 for sheet materials. Average thermal conductivity of 0.25 BTU/Hr/Sq.Ft/Deg. F at 75 degrees mean temperature per inch thickness.

2.02 FIRE-RATED INSULATION SYSTEMS

- A. Fire-Rated Board - Type FRB1H:
 - 1. Manufacturers:
 - a. Johns Manville; Super Firetemp M.
 - 2. Structural-grade, press-molded, xonolite calcium silicate, fireproofing board suitable for operating temperatures up to 1700 deg F (927 deg C). Comply with ASTM C656, Type II, Grade 6. tested and certified to provide a 1-hour fire rating by a NRTL acceptable to authority having jurisdiction.
- B. Fire-Rated Insulation Blanket - Type FRB2H:
 - 1. Manufacturers:
 - a. CertainTeed Corp.; FlameChek.
 - b. Johns Manville; Firetemp Wrap.
 - c. Nelson Fire Stop Products; Nelson FSB Flameshield Blanket.
 - d. Thermal Ceramics; FireMaster Duct Wrap.

- e. 3M; Fire Barrier Wrap Products.
 - f. Unifrax Corporation; FyreWrap.
- 2. High-temperature, flexible, blanket insulation with FSK jacket that is tested and certified to provide a 2-hour fire rating by a NRTL acceptable to authority having jurisdiction.
- C. Removable Blanket Insulation Systems for Engine and Generator Exhaust Components
 - 1. Manufacturers:
 - a. A-B Thermal Technologies.
 - 2. Description: Insulating blankets for mufflers, silencers, turbo chargers, elbows, flex pipes, straight pipes and flanges listed for use on diesel, gasoline/petrol and gas turbine engines. Removable blanket sections assembled with either locking wire or spring clips connecting the mushroom rivets or hook fasteners that are mounted on the blankets. Custom made to form fit components.
 - 3. Temperature Rating: 1200 deg F (648 deg C).
 - 4. Listings: Removable blanket insulation systems shall meet the following listing requirements:
 - a. Underwriters Laboratories (UL 2200).
 - b. MIL-1-24222.
 - c. USCG 164.009.
 - d. ASTM E84.
 - 5. Insulation: Needled fiberglass felt.
 - 6. Thickness: Minimum 1 inch (25 mm) thick.
 - 7. Hot side layer: Stainless steel knitted mesh fabric.
 - 8. Cold side cover fabric: 2 side silicone rubber coated fiberglass

2.03 INSULATING CEMENTS

- A. Mineral-Fiber Insulating Cement: Comply with ASTM C195.
 - 1. Manufacturers:
 - a. Ramco Insulation, Inc.; Super-Stik.
- B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C196.
 - 1. Manufacturers:
 - a. Ramco Insulation, Inc.; Thermokote V.
- C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C449.
 - 1. Manufacturers:
 - a. Ramco Insulation, Inc.; Ramcote 1200 and Quik-Cote.

2.04 ADHESIVES

- A. Adhesives, mastics, insulating cements, lagging adhesives, and sealants shall be compatible with insulation materials, jackets, and substrates to which applied, and suitable for operating temperatures of equipment, piping and duct systems.
 - 1. For indoor applications, VOC content shall be 50 g/L or less.
 - a. For calcium silicate insulation and Mineral- Wool / Fiber adhesives, VOC content shall be 80 g/L or less.
 - 2. For joint sealants, VOC content shall be 420 g/L or less.
- B. Calcium Silicate Adhesive: Fibrous, sodium-silicate-based adhesive with a service temperature range of 50 to 800 deg F (10 to 427 deg C).
 - 1. Manufacturers:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-97.
 - b. Eagle Bridges - Marathon Industries; 290.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 81-27.
 - d. Mon-Eco Industries, Inc.; 22-30.

- e. Vimasco Corporation; 760.
- 2. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- 3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- C. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F (minus 73 to plus 93 deg C).
 - 1. Manufacturers:
 - a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 81-84.
 - 2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- D. Phenolic and Polyisocyanurate Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F (minus 59 to plus 149 deg C).
 - 1. Manufacturers:
 - a. Childers Products, Division of ITW; CP-96.
 - b. Foster Products Corporation, H. B. Fuller Company; 81-33.
 - 2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- E. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179, Type II, Class I.
 - 1. Manufacturers:
 - a. Aeroflex USA, Inc.; Aeroseal.
 - b. Armacell LLC; Armaflex 520 Adhesive.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.
 - d. K-Flex USA; R-373 Contact Adhesive.
 - 2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- F. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 - 1. Manufacturers:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
 - b. Eagle Bridges - Marathon Industries; 225.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.
 - d. Mon-Eco Industries, Inc.; 22-25.
 - 2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- G. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
 1. Manufacturers:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
 - b. Eagle Bridges - Marathon Industries; 225.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.
 - d. Mon-Eco Industries, Inc.; 22-25.
 2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- H. PVC Jacket Adhesive: Compatible with PVC jacket.
 1. Manufacturers:
 - a. Dow Corning Corporation; 739, Dow Silicone.
 - b. Johns Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
 - c. P.I.C. Plastics, Inc.; Welding Adhesive.
 - d. Speedline Corporation; Polyco VP Adhesive.
 2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.05 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.
 1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 2. For Water-based Vapor-Barrier Mastic, permeance shall be 0.013 perm or better.
 3. For Solvent based Vapor-Barrier Mastic, permeance shall be 0.05 perm or better.
 4. For Water-based Breather Mastic, permeance shall be 1.8 perms or better.
 5. Mastics shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.
 1. Manufacturers:
 - a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.
 - b. Vimasco Corporation; 749.
 2. Water-Vapor Permeance: ASTM E96/E96M, Procedure B, 0.013 perm (0.009 metric perm) at 43 mil (1.09 mm) dry film thickness.
 3. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).
 4. Solids Content: ASTM D1644, 58 percent by volume and 70 percent by weight.
 5. Color: White.
- C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below ambient services.

1. Manufacturers:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-30.
 - b. Eagle Bridges - Marathon Industries; 501.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-35.
 - d. Mon-Eco Industries, Inc.; 55-10.
 2. Water-Vapor Permeance: ASTM F1249, 0.05 perm (0.03 metric perm) at 35 mil (0.9 mm) dry film thickness.
 3. Service Temperature Range: 0 to plus 180 deg F (Minus 18 to plus 82 deg C).
 4. Solids Content: ASTM D1644, 44 percent by volume and 62 percent by weight.
 5. Color: White.
- D. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below ambient services.
1. Manufacturers:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Encacel.
 - b. Eagle Bridges - Marathon Industries; 570.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 60-95/60-96.
 2. Water-Vapor Permeance: ASTM F1249, 0.05 perm (0.033 metric perm) at 30 mil (0.8 mm) dry film thickness.
 3. Service Temperature Range: Minus 50 to plus 220 deg F (Minus 46 to plus 104 deg C).
 4. Solids Content: ASTM D1644, 33 percent by volume and 46 percent by weight.
 5. Color: White.
- E. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
1. Manufacturers:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-10.
 - b. Eagle Bridges - Marathon Industries; 550.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 46-50.
 - d. Mon-Eco Industries, Inc.; 55-50.
 - e. Vimasco Corporation; WC-1/WC-5.
 2. Water-Vapor Permeance: ASTM F1249, 1.8 perms (1.2 metric perms) at 0.0625 inch (1.6 mm) dry film thickness.
 3. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).
 4. Solids Content: 60 percent by volume and 66 percent by weight.
 5. Color: White.

2.06 LAGGING ADHESIVES

- A. Description: Comply with MIL-A-3316C Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 2. Manufacturers:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-50 AHV2.
 - b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-36.
 - c. Vimasco Corporation; 713 and 714.
 3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct, equipment, and pipe insulation.

4. Service Temperature Range: 0 to plus 180 deg F (Minus 18 to plus 82 deg C).
5. Color: White.

2.07 SEALANTS

- A. Joint Sealants:
 1. Joint Sealants for Cellular-Glass, Phenolic, and Polyisocyanurate Products:
 - a. Manufacturers:
 - 1) Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
 - 2) Eagle Bridges - Marathon Industries; 405.
 - 3) Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-45.
 - 4) Mon-Eco Industries, Inc.; 44-05.
 - 5) Pittsburgh Corning Corporation; Pittseal 444.
- B. FSK and Metal Jacket Flashing Sealants:
 1. Manufacturers:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
 - b. Eagle Bridges - Marathon Industries; 405.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
 - d. Mon-Eco Industries, Inc.; 44-05.
 2. Materials shall be compatible with insulation materials, jackets, and substrates.
 3. Fire- and water-resistant, flexible, elastomeric sealant.
 4. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
 5. Color: Aluminum.
 6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
 1. Manufacturers:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
 2. Materials shall be compatible with insulation materials, jackets, and substrates.
 3. Fire- and water-resistant, flexible, elastomeric sealant.
 4. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
 5. Color: White.
 6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.08 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
 1. All Service Jacket - Type J1:
 - a. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.

- b. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I
- 2. FSK Jacket - Type J2:
 - a. Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type II.
- 3. FSP Jacket - Type J3:
 - a. Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C1136, Type II.
- 4. PVDC Jacket for Indoor and Outdoor Applications - Type J4:
 - a. 6 mil (0.15 mm) thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perms (0.007 metric perms) when tested according to ASTM E96/E96M and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E84.
 - 1) Manufacturers:
 - (a) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.
- 5. PSK Jacket - Type J5:
 - a. Metalized Polypropylene, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II
- 6. Vinyl Jacket - Type J6:
 - a. Vinyl Jacket: White vinyl with a permeance of 1.3 perms (0.86 metric perms) when tested according to ASTM E96/E96M , Procedure A, and complying with NFPA 90A and {RS#1880}.

2.09 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C921, Type I, unless otherwise indicated.
- B. PVC Jacket - Type J7:
 - 1. High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
 - 2. Manufacturers:
 - a. Johns Manville; Zeston.
 - b. P.I.C. Plastics, Inc.; FG Series.
 - c. Proto Corporation; LoSmoke.
 - 3. Adhesive: As recommended by jacket material manufacturer.
 - 4. Color: White.
 - 5. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
 - a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.
 - 6. Factory-fabricated tank heads and tank side panels.
- C. Metal Jackets:
 - 1. Manufacturers:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Metal Jacketing Systems.
 - b. ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.
 - c. RPR Products, Inc.; Insul-Mate.
 - 2. Aluminum Jacket Type J8: Comply with ASTM B209/B209M, Alloy 3003, 3005, 3105 or 5005, Temper H-14.
 - a. Finish and thickness are indicated in field-applied jacket schedules.
 - b. Finish and thickness are indicated in field-applied jacket schedules.

- c. Moisture Barrier for Indoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
 - d. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
 - e. Factory-Fabricated Fitting Covers:
 - 1) Same material, finish, and thickness as jacket.
 - 2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
 - 3) Tee covers.
 - 4) Flange and union covers.
 - 5) End caps.
 - 6) Beveled collars.
 - 7) Valve covers.
 - 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.
3. Stainless-Steel Jacket Type J9
- a. ASTM A167 or ASTM A240/A240M.
 - b. Factory cut and rolled to size.
 - c. Material, finish, and thickness are indicated in field-applied jacket schedules.
 - d. Moisture Barrier for Indoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
 - e. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
 - f. Factory-Fabricated Fitting Covers:
 - 1) Same material, finish, and thickness as jacket.
 - 2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
 - 3) Tee covers.
 - 4) Flange and union covers.
 - 5) End caps.
 - 6) Beveled collars.
 - 7) Valve covers.
 - 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.
- D. Self-Adhesive Outdoor Jacket - Type J10:
- 1. Manufacturers:
 - a. Polyguard Products, Inc.; Alumaguard 60.
 - 2. 60 mil (1.5 mm) thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a cross laminated polyethylene film covered with white aluminum-foil facing.
- E. PVDC Jacket for Indoor and Outdoor Applications - Type J4 (Same as Factory Applied):
- 1. Manufacturers:
 - a. Dow Chemical Company (The); Saran 540 Vapor Retarder Film.
 - 2. 4 mil (0.10 mm) thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms (0.013 metric perms) when tested according to ASTM E96/E96M and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E84.
- F. Underground Direct-Buried Jacket - Type J11:
- 1. Manufacturers:
 - a. Pittsburgh Corning Corporation; Pittwrap.
 - b. Polyguard Products, Inc.; Insulrap No Torch 125.

2. 125 mil (3.2 mm) thick vapor barrier and waterproofing membrane consisting of a rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.

2.10 REMOVABLE, RE-USABLE INSULATING JACKETS

- A. Custom factory fabricated, close-fitting contoured insulating jacket to fully cover equipment including flange connections to adjacent piping. Jackets shall be capable of removal and reinstallation without modification. Insulation material and thickness shall be sufficient to maintain an outer jacket surface temperature of 100 degrees F or less.
 1. Manufacturers:
 - a. Fit Tight Covers
 - b. Thermal Energy Products, Inc.
 - c. Thermax
 2. Materials:
 - a. Interior Fabric and Exterior Fabric: 16.5 Oz/Sq Yd PTFE Teflon impregnated or silicon impregnated fiberglass cloth
 - b. Insulation: Minimum One inch thick fiberglass mat insulation, 11.25 lbs/cu.ft. density, maximum temperature rating to 1200 degrees.
 - c. Securement: 14 gage stainless steel buckles and strap assembly
 - d. Thread: Kevlar with stainless steel core
 - e. Drawcord closure: 0.125 inch diameter polyester drawcord
 3. Construction:
 - a. All seams to be double sewn, using a double locked stitch, minimum 6 stitches per inch. No raw cut jacket edges shall be exposed.
 - b. Hog rings or staples are not acceptable.
 - c. Insulation shall be held in place with stainless steel quilt pins between the interior and exterior fabric to prevent shifting. Pins shall not penetrate inner surface cover.
 - d. Jackets shall be a maximum of three pieces. Jackets shall be fastened using hook and loop (Velcro) straps and 1 inch (25 mm) slide buckles. End closure with drawcord tie-downs to extend onto adjacent pipe insulation.
 - e. Provide a permanently attached nameplate on each jacket to identify insulated equipment. Provide a stainless steel or brass grommet at the low-point for moisture drain, and at the high point as a vent.
- B. Field-Applied Fabric-Reinforcing Mesh
 1. Woven Glass-Fiber Fabric for Pipe Insulation: Approximately 2 oz/sq. yd (68 g/sq. m) with a thread count of 10 strands by 10 strands/sq. inch (4 strands by 4 strands/sq. mm) for covering pipe and pipe fittings.
 - a. Manufacturers:
 - 1) Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Chil-Glas Number 10.
 2. Woven Glass-Fiber Fabric for Duct and Equipment Insulation: Approximately 6 oz/sq. yd (203 g/sq. m) with a thread count of 5 strands by 5 strands/sq. inch (2 strands by 2 strands/sq. mm) for covering equipment.
 - a. Manufacturers:
 - 1) Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Chil-Glas No. 5.
 3. Woven Polyester Fabric: Approximately 1 oz/sq. yd (34 g/sq. m) with a thread count of 10 strands by 10 strands/sq. inch (4 strands by 4 strands/sq. mm), in a Leno weave, for duct, equipment, and pipe.
 - a. Manufacturers:
 - 1) Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Mast-A-Fab.
 - 2) Vimasco Corporation; Elastafab 894.

C. Field-Applied Cloths

1. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz/sq. yd (271 g/sq. m).
 - a. Manufacturers:
 - 1) Alpha Associates, Inc.; Alpha-Maritex 84215 and 84217/9485RW, Luben 59.

2.11 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.
 1. Manufacturers:
 - a. ABI, Ideal Tape Division; 428 AWF ASJ.
 - b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
 - c. Compac Corporation; 104 and 105.
 - d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
 - e. Knauf Insulation
 2. Width: 3 inches (75 mm).
 3. Thickness: 11.5 mils (0.29 mm).
 4. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
 5. Elongation: 2 percent.
 6. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
 7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C1136.
 1. Manufacturers:
 - a. ABI, Ideal Tape Division; 491 AWF FSK.
 - b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
 - c. Compac Corporation; 110 and 111.
 - d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.
 - e. Knauf Insulation
 2. Width: 3 inches (75 mm).
 3. Thickness: 6.5 mils (0.16 mm).
 4. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
 5. Elongation: 2 percent.
 6. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
 7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
- C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.
 1. Manufacturers:
 - a. ABI, Ideal Tape Division; 370 White PVC tape.
 - b. Compac Corporation; 130.
 - c. Venture Tape; 1506 CW NS.
 - d. Knauf Insulation
 2. Width: 2 inches (50 mm).
 3. Thickness: 6 mils (0.15 mm).
 4. Adhesion: 64 ounces force/inch (0.7 N/mm) in width.
 5. Elongation: 500 percent.
 6. Tensile Strength: 18 lbf/inch (3.3 N/mm) in width.
- D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
 1. Manufacturers:
 - a. ABI, Ideal Tape Division; 488 AWF.
 - b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.

- c. Compac Corporation; 120.
 - d. Venture Tape; 3520 CW.
 - e. Knauf Insulation
- 2. Width: 2 inches (50 mm).
- 3. Thickness: 3.7 mils (0.093 mm).
- 4. Adhesion: 100 ounces force/inch (1.1 N/mm) in width.
- 5. Elongation: 5 percent.
- 6. Tensile Strength: 34 lbf/inch (6.2 N/mm) in width.
- E. PVDC Tape for Indoor and Outdoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.
 - 1. Manufacturers:
 - a. Dow Chemical Company (The); Saran 560 Vapor Retarder Tape.
 - 2. Width: 3 inches (75 mm).
 - 3. Film Thickness: 6 mils (0.15 mm).
 - 4. Adhesive Thickness: 1.5 mils (0.04 mm).
 - 5. Elongation at Break: 145 percent.
 - 6. Tensile Strength: 55 lbf/inch (10.1 N/mm) in width.

2.12 SECUREMENTS

- A. Bands:
 - 1. Manufacturers:
 - a. ITW Insulation Systems; Gerrard Strapping and Seals.
 - b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs
 - 2. Stainless Steel: ASTM A167 or ASTM A240/A240M, Type 304; 0.015 inch (0.38 mm) thick, 1/2 inch (13 mm) wide with wing seal.
 - 3. Aluminum: ASTM B209/B209M, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch (0.51 mm) thick, 1/2 inch (13 mm) wide with wing seal.
 - 4. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.
- B. Insulation Pins and Hangers:
 - 1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106 inch (2.6 mm) diameter shank, length to suit depth of insulation indicated.
 - a. Manufacturers:
 - 1) AGM Industries, Inc.; CWP-1.
 - 2) GEMCO; CD.
 - 3) Midwest Fasteners, Inc.; CD.
 - 4) Nelson Stud Welding; TPA, TPC, and TPS.
 - 2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106 inch (2.6 mm) diameter shank, length to suit depth of insulation indicated with integral 1-1/2 inches (38 mm) galvanized carbon-steel washer.
 - a. Manufacturers:
 - 1) AGM Industries, Inc.; CHP-1.
 - 2) GEMCO; Cupped Head Weld Pin.
 - 3) Midwest Fasteners, Inc.; Cupped Head.
 - 4) Nelson Stud Welding; CHP.
 - 3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Manufacturers:

- 1) AGM Industries, Inc.; Tactoo Perforated Base Insul-Hangers.
 - 2) GEMCO; Perforated Base.
 - 3) Midwest Fasteners, Inc.; Spindle.
 - b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50 mm) square.
 - c. Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106 inch (2.6 mm) diameter shank, length to suit depth of insulation indicated.
 - d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
4. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
- a. Manufacturers:
 - 1) GEMCO; Nylon Hangers.
 - 2) Midwest Fasteners, Inc.; Nylon Insulation Hangers.
 - b. Baseplate: Perforated, nylon sheet, 0.030 inch (0.76 mm) thick by 1-1/2 inches (38 mm) in diameter.
 - c. Spindle: Nylon, 0.106 inch (2.6 mm) diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches (63 mm).
 - d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
5. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
- a. Manufacturers:
 - 1) AGM Industries, Inc.; Tactoo Self-Adhering Insul-Hangers.
 - 2) GEMCO; Peel & Press.
 - 3) Midwest Fasteners, Inc.; Self Stick.
 - b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50 mm) square.
 - c. Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106 inch (2.6 mm) diameter shank, length to suit depth of insulation indicated.
 - d. Adhesive-backed base with a peel-off protective cover.
6. Insulation-Retaining Washers: Self-locking washers formed from 0.016 inch (0.41 mm) thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.
- a. Manufacturers:
 - 1) AGM Industries, Inc.; RC-150.
 - 2) GEMCO; R-150.
 - 3) Midwest Fasteners, Inc.; WA-150.
 - 4) Nelson Stud Welding; Speed Clips.
 - b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
7. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016 inch (0.41 mm) thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.
- a. Manufacturers:
 - 1) GEMCO.
 - 2) Midwest Fasteners, Inc.

- C. Staples: Outward-clinching insulation staples, nominal 3/4 inch (19 mm) wide, stainless steel or Monel.
- D. Wire: 0.080 inch (2.0 mm) nickel-copper alloy.
 - 1. Manufacturers:
 - a. C & F Wire.

2.13 CORNER ANGLES

- A. PVC Corner Angles: 30 mils (0.8 mm) thick, minimum 1 by 1 inch (25 by 25 mm), PVC according to ASTM D1784, Class 16354-C. White or color-coded to match adjacent surface.
- B. Aluminum Corner Angles: 0.040 inch (1.0 mm) thick, minimum 1 by 1 inch (25 by 25 mm), aluminum according to ASTM B209/B209M, Alloy 3003, 3005, 3105 or 5005; Temper H-14.
- C. Stainless-Steel Corner Angles: 0.024 inch (0.61 mm) thick, minimum 1 by 1 inch (25 by 25 mm), stainless steel according to ASTM A167 or ASTM A240/A240M, Type 304.

2.14 UNDERSINK ADA PROTECTIVE SHIELDING GUARDS

- A. Protective Shielding Pipe Covers:
 - 1. Manufacturers:
 - a. Truebro; a brand of IPS Corporation.
 - b. Zurn Industries, LLC; Tubular Brass Plumbing Products Operation.
 - c. Engineered Brass Company.
 - d. Insul-Tect Products Co.; a subsidiary of MVG Molded Products.
 - e. McGuire Manufacturing.
 - f. Plumberex.
 - 2. Description: Manufactured plastic wraps for covering plumbing fixture hot-water supply and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.
- B. Protective Shielding Piping Enclosures:
 - 1. Manufacturers:
 - a. Truebro; a brand of IPS Corporation.
 - b. Zurn Industries, LLC; Tubular Brass Plumbing Products Operation.
 - 2. Description: Manufactured plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA requirements.

PART 3 EXECUTION

3.01 APPLICATION

- A. General
 - 1. Acceptable insulation materials and thicknesses are identified for each piping system, pipe size range and equipment type. If more than one material is listed for a system, selection from materials listed is Contractor's option.
- B. Diesel Fire Pump Piping and Equipment
 - 1. Indoor and Outdoor, Exposed, Rigid, Engine Exhaust Pipe:
 - a. Calcium Silicate: 4 inches (100 mm) thick.
 - 2. Diesel Engine Silencer (Muffler):
 - a. Removable Blanket Insulation System for Engine and Generator Exhaust Components.
 - 3. Indoor and Outdoor Engine Coolant Piping for Remote Radiator of Engine-Driven Fire Pump:
 - a. All Pipe Sizes: Insulation shall be one of the following:
 - 1) Calcium Silicate: 2 inches (50 mm) thick.
 - 2) Cellular Glass: 2 inches (50 mm thick).
- C. Outdoor Fire Water Storage Tank

1. Cellular Glass: 1 inch (25 mm) thick.
2. Polyisocyanurate: 1 inch (25 mm) thick.
- D. Indoor Fire Protection System Water-Filled Piping
 1. Cellular Glass: 1 inch (25 mm) thick.
- E. Outdoor, Aboveground Fire Protection System Water-Filled Piping
 1. Cellular Glass: 1 inch (25 mm) thick.
- F. Indoor Fire Protection, Field-Applied Jacket
 1. Piping, Concealed:
 - a. None.
 - b. Painted Aluminum, Smooth, 0.024 inch (0.61 mm) 0.024 inch (0.61 mm) thick with Z-shaped locking seam.
 - c. Stainless Steel, Type 304, Smooth 2B Finish, 0.016 inch (0.41 mm) 0.016 inch (0.41 mm) thick with Z-Shaped locking seam.
 2. Piping, Exposed:
 - a. None.
 - b. PVC, 20 mils (0.5 mm) thick.
 - c. Painted Aluminum, Smooth, 0.024 inch (0.61 mm) thick with Z-shaped locking seam.
 - d. Stainless Steel, Type 304, Smooth 2B Finish, 0.016 inch (0.41 mm) thick with Z-Shaped locking seam.
- G. Outdoor Fire Protection, Field-Applied Jacket
 1. Fire Water Storage Tanks, Larger Than 48 inches (1200 mm) in Diameter or with Flat Surfaces Larger Than 72 inches (1800 mm):
 - a. Painted Aluminum, Smooth with 1-1/4 inch (32 mm) Deep Corrugations, 0.032 inch (0.81 mm) thick with Z-shaped locking seam.
 - b. Stainless Steel, Type 304, Smooth 2B Finish with 1-1/4 inch (32 mm) Deep Corrugations, 0.020 inch (0.51 mm) thick with Z-shaped locking seam.
 2. Outdoor Exposed Piping:
 - a. PVC, 20 mils (0.5 mm) thick.
 - b. Painted Aluminum, Smooth, 0.024 inch (0.61 mm) thick with Z-shaped locking seam.
 - c. Stainless Steel, Type 304, Smooth 2B Finish, 0.016 inch (0.41 mm) thick with Z-Shaped locking seam.

3.02 EXAMINATION

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

3.03 PREPARATION

- A. Surface Preparation (Conditioned Spaces): Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Surface Preparation (Unconditioned Spaces and Exposed to Weather): Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
 1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils (0.127 mm) thick and an epoxy finish 5 mils (0.127 mm) thick if operating in a temperature range between 140 and 300 deg F (60 and 149 deg C). Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F (0 and 149 deg C) with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
- C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.04 INSTALLATION

- A. General
 1. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.
 2. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.
 3. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
 4. Install insulation with longitudinal seams at top and bottom of horizontal runs.
 5. Install multiple layers of insulation with longitudinal and end seams staggered.
 6. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
 7. Keep insulation materials dry during application and finishing.
 8. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
 9. Install insulation with least number of joints practical.
 10. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - a. Install insulation continuously through hangers and around anchor attachments.
 - b. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - c. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 - d. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
 11. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
 12. Install insulation with factory-applied jackets as follows:
 - a. Draw jacket tight and smooth.
 - b. Cover circumferential joints with 3 inch (75 mm) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches (100 mm) o.c.
 - c. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches (50 mm) o.c.
 - 1) For below ambient services, apply vapor-barrier mastic over staples.
 - d. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.

- e. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.
 - 13. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
 - 14. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
 - 15. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
 - 16. For above ambient services, do not install insulation to the following:
 - a. Vibration-control devices.
 - b. Testing agency labels and stamps.
 - c. Nameplates and data plates.
 - d. Manholes.
 - e. Handholes.
 - f. Cleanouts.
- B. Penetrations
- 1. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
 - a. Seal penetrations with flashing sealant.
 - b. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - c. Extend jacket of outdoor insulation outside roof flashing at least 2 inches (50 mm) below top of roof flashing.
 - d. Seal jacket to roof flashing with flashing sealant.
 - 2. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
 - 3. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
 - a. Seal penetrations with flashing sealant.
 - b. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - c. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches (50 mm).
 - d. Seal jacket to wall flashing with flashing sealant.
 - 4. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
 - 5. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions. Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches (50 mm).
 - a. Comply with requirements in Division 07 Section 07 84 13 "Penetration Firestopping" and fire-resistive joint sealers.
 - 6. Insulation Installation at Floor Penetrations:
 - a. Duct: Install insulation continuously through floor penetrations that are not fire rated. For penetrations through fire-rated assemblies, terminate insulation at fire damper

- sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches (50 mm).
- b. Pipe: Install insulation continuously through floor penetrations.
 - c. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."
- C. Equipment, Tank, and Vessel Installation
- 1. Glass Mineral Wool, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with anchor pins and speed washers.
 - a. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of tank and vessel surfaces.
 - b. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
 - c. Protect exposed corners with secured corner angles.
 - d. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:
 - 1) Do not weld anchor pins to ASME-labeled pressure vessels.
 - 2) Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
 - 3) On tanks and vessels, maximum anchor-pin spacing is 3 inches (75 mm) from insulation end joints, and 16 inches (400 mm) o.c. in both directions.
 - 4) Do not overcompress insulation during installation.
 - 5) Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
 - 6) Impale insulation over anchor pins and attach speed washers.
 - 7) Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
 - e. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
 - f. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches (150 mm) from each end. Install wire or cable between two circumferential girdles 12 inches (300 mm) o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches (1200 mm) o.c. Use this network for securing insulation with tie wire or bands.
 - g. Stagger joints between insulation layers at least 3 inches (75 mm).
 - h. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
 - i. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
 - j. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.
 - 2. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.
 - a. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.

- b. Seal longitudinal seams and end joints.
- 3. Insulation Installation on Pumps:
 - a. Insulate Chilled Water Pumps as follows:
 - 1) Install Flexible Elastomeric insulation over entire surface of pump. Apply 100 percent coverage of adhesive to exterior surface of pump casing and flanges and seal longitudinal seams and end joints with manufacturer's recommended adhesive.
 - 2) Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6 inch (150 mm) centers, starting at corners. Install 3/8 inch (10 mm) diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.
 - (a) Fabricate boxes from aluminum sheet, at least 0.060 inch (1.6 mm) thick, and aluminum corner angles.
 - (b) Line box with 2 inch (50 mm) thickness of Flexible Elastomeric insulation. Apply 100 percent coverage of adhesive to interior surface of box and seal longitudinal seams and end joints with manufacturer's recommended adhesive.
 - (c) Install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.
 - b. Insulate Heating Hot Water Pumps as follows:
 - 1) Fabricate metal boxes lined with insulation. Comply with MICA National Insulation Standard Plate No. 8-400. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch centers, starting at corners. Install 3/8-inch-diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.
 - 2) Fabricate boxes from aluminum sheet, at least 0.060 inch (1.6 mm) thick, and aluminum corner angles.
 - 3) Line box with 2 inch (50 mm) thickness of same insulation as applied to adjacent pipe. Apply 100 percent coverage of adhesive to interior surface of box and seal longitudinal seams and end joints with manufacturer's recommended adhesive.
 - 4) Provide a Removable, Re-usable Insulating Jacket on each pump
- D. General Pipe Insulation Installation
 - 1. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
 - 2. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
 - a. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
 - b. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 - c. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 - d. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets,

- valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
- e. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
 - f. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 - g. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 - h. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 - i. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.
3. Provide protective shielding guards on exposed piping serving barrier free sinks and lavatories.
 4. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
 5. Install removable insulation covers at locations indicated. Installation shall conform to the following:
 - a. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
 - b. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
 - c. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
 - d. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches (50 mm) over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
 - e. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.
 - f. For HVAC Systems, Install Removable, Re-usable Insulating Jacket in lieu of pipe insulation on the following:

- 1) Hot pipe expansion joints
 - 2) Emergency generator pipe expansion joints
 - 3) Strainers in hot piping
 - g. Unions in hot piping
 - 1) Steam Traps
 - 2) Other indicated locations
- E. Calcium Silicate Insulation Installation
 - 1. Insulation Installation on Boiler Breechings and Ducts:
 - a. Secure single-layer insulation with stainless-steel bands at 12 inch (300 mm) intervals and tighten bands without deforming insulation material.
 - b. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches (75 mm). Secure inner layer with wire spaced at 12 inch (300 mm) intervals. Secure outer layer with stainless-steel bands at 12 inch (300 mm) intervals.
 - c. On exposed applications without metal jacket, finish insulation surface with a skim coat of mineral-fiber, hydraulic-setting cement. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth. Overlap edges at least 1 inch (25 mm). Apply finish coat of lagging adhesive over glass cloth. Thin finish coat to achieve smooth, uniform finish.
 - 2. Insulation Installation on Straight Pipes and Tubes:
 - a. Secure single-layer insulation with stainless-steel bands at 12 inch (300 mm) intervals and tighten bands without deforming insulation materials.
 - b. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches (75 mm). Secure inner layer with wire spaced at 12 inch (300 mm) intervals. Secure outer layer with stainless-steel bands at 12 inch (300 mm) intervals.
 - c. Apply a skim coat of mineral-fiber, hydraulic-setting cement to insulation surface. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth or tape. Overlap edges at least 1 inch (25 mm). Apply finish coat of lagging adhesive over glass cloth or tape. Thin finish coat to achieve smooth, uniform finish.
 - 3. Insulation Installation on Pipe Flanges:
 - a. Install preformed pipe insulation to outer diameter of pipe flange.
 - b. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 - c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as pipe insulation.
 - d. Finish flange insulation same as pipe insulation.
 - 4. Insulation Installation on Pipe Fittings and Elbows:
 - a. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
 - b. When preformed insulation sections of insulation are not available, install mitered sections of calcium silicate insulation. Secure insulation materials with wire or bands.
 - c. Finish fittings insulation same as pipe insulation.
 - 5. Insulation Installation on Valves and Pipe Specialties:
 - a. Install mitered segments of calcium silicate insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 - b. Install insulation to flanges as specified for flange insulation application.
 - c. Finish valve and specialty insulation same as pipe insulation.
- F. Cellular Glass Insulation Installation
 - 1. Insulation Installation on Straight Pipes and Tubes:

- a. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
 - b. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
 - c. For insulation with factory-applied jackets on above ambient services, secure laps with outward clinched staples at 6 inches (150 mm) o.c.
 - d. For insulation with factory-applied jackets on below ambient services, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
 2. Insulation Installation on Pipe Flanges:
 - a. Install preformed pipe insulation to outer diameter of pipe flange.
 - b. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 - c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
 - d. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25 mm), and seal joints with flashing sealant.
 3. Insulation Installation on Pipe Fittings and Elbows:
 - a. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
 - b. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.
 4. Insulation Installation on Valves and Pipe Specialties:
 - a. Install preformed sections of cellular-glass insulation to valve body.
 - b. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 - c. Install insulation to flanges as specified for flange insulation application.
- G. Flexible Elastomeric Insulation Installation
1. Install insulation in accordance with manufacturer's installation instructions ASTM C1710
 2. Seal longitudinal seams and end joints with manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
 3. Insulation Installation on Pipe Flanges:
 - a. Slit tubular sections and apply onto piping or tubing.
 - b. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation.
 - c. Install insulation in compression to allow for expansion and contraction.
 - d. Push insulation onto pipe, do not pull insulation onto pipe.
 - e. For below-ambient temperature systems, adhere insulation to pipe at least every 18 ft. using manufacturer's recommended adhesive. Terminate joints at critical points, including flanges, T-sections, elbows, supports, and similar fittings
 4. Insulation Installation on Pipe Flanges:
 - a. Install preformed flange covers manufactured of same material as pipe insulation, when available
 - b. Install pipe insulation to outer diameter of pipe flange.
 - c. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 - d. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.

- e. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated
- 5. Insulation Installation on Pipe Fittings and Elbows:
 - a. Install preformed flange covers manufactured of same material as pipe insulation, when available.
 - b. Install mitered sections of pipe insulation.
 - c. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- 6. Insulation Installation on Valves and Pipe Specialties:
 - a. Install preformed valve covers manufactured of same material as pipe insulation when available.
 - b. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 - c. Install insulation to flanges as specified for flange insulation application.
 - d. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- H. Mineral-Fiber Insulation Installation
 - 1. Insulation Installation on Straight Pipes and Tubes:
 - a. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
 - b. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
 - c. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches (150 mm) o.c.
 - d. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
 - 2. Insulation Installation on Pipe Flanges:
 - a. Install preformed pipe insulation to outer diameter of pipe flange.
 - b. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 - c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
 - d. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25 mm), and seal joints with flashing sealant.
 - e. Raw ends of pipe insulation sections shall be coated with vapor retarder mastic at 12 ft to 21 ft intervals, and on either side of fittings, flanges and valves. Vapor retarder mastic shall completely coat the ends of the pipe insulation and extend onto the bore of the pipe insulation and onto the jacketing a minimum of 2 inches.
 - 3. Insulation Installation on Pipe Flanges:
 - a. Install preformed pipe insulation to outer diameter of pipe flange.
 - b. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 - c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
 - d. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25 mm), and seal joints with flashing sealant.

4. Insulation Installation on Pipe Fittings and Elbows:
 - a. Provide flexible wrap with PVC fittings.
5. Insulation Installation on Valves and Pipe Specialties:
 - a. Install preformed sections of same material as straight segments of pipe insulation when available.
 - b. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
 - c. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 - d. Install insulation to flanges as specified for flange insulation application.
6. Blanket Insulation Installation on Ducts and Plenums:
 - a. Secure with adhesive and insulation pins.
 - b. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
 - c. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
 - d. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - 1) On duct sides with dimensions 18 inches (450 mm) and smaller, place pins along longitudinal centerline of duct. Space 3 inches (75 mm) maximum from insulation end joints, and 16 inches (400 mm) o.c.
 - 2) On duct sides with dimensions larger than 18 inches (450 mm), place pins 16 inches (400 mm) o.c. each way, and 3 inches (75 mm) maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - 3) Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - 4) Do not overcompress insulation during installation.
 - 5) Impale insulation over pins and attach speed washers.
 - 6) Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
 - e. Install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches (50 mm) from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch (25 mm) o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
 - 1) On faced blanket insulation, Contractor may use "fold-over and staple-stitch" method to form longitudinal seams joining adjacent sides of insulation. Secure seam with outward-clinching staples spaced not more than 4 inches on center.
 - 2) Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - 3) Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.
 - f. Overlap unfaced blankets a minimum of 2 inches (50 mm) 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.

- g. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
 - h. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.
- 7. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins
 - a. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - 1) On duct sides with dimensions 18 inches (450 mm) and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - 2) On duct sides with dimensions larger than 18 inches (450 mm), space pins 16 inches o.c. each way, and 3 inches (75 mm) maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - 3) Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - 4) Do not overcompress insulation during installation.
 - 5) Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing
 - b. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches (50 mm) from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2 inch (13 mm) outward-clinching staples, 1 inch (25 mm) o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
 - 1) Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - 2) Install vapor stops for ductwork and plenums operating below 50 deg F (10 deg C) at 18 foot (5.5 m) intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches (75 mm).
 - c. Overlap unfaced blankets a minimum of 2 inches (50 mm) on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches (450 mm) o.c.
 - d. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
 - e. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6 inch (150 mm) wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches (150 mm) o.c.
- 8. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
 - a. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.

- b. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
 - c. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - 1) On duct sides with dimensions 18 inches (450 mm) and smaller, place pins along longitudinal centerline of duct. Space 3 inches (75 mm) maximum from insulation end joints, and 16 inches (400 mm) o.c.
 - 2) On duct sides with dimensions larger than 18 inches (450 mm), space pins 16 inches (400 mm) o.c. each way, and 3 inches (75 mm) maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - 3) Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - 4) Do not overcompress insulation during installation.
 - 5) Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
 - d. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches (50 mm) from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2 inch (13 mm) outward-clinching staples, 1 inch (25 mm) o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
 - 1) Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - 2) Install vapor stops for ductwork and plenums operating below 50 deg F (10 deg C) at 18 foot (5.5 m) intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches (75 mm).
 - e. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
 - f. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6 inch (150 mm) wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches (150 mm) o.c.
9. Glass fiber, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.
- a. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50 percent coverage of tank and vessel surfaces located inside the building, and for 100 percent coverage of tank and vessel surfaces located outside the building.
 - b. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
 - c. Protect exposed corners with secured corner angles.
 - d. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:
 - 1) Do not weld anchor pins to ASME-labeled pressure vessels.

- e. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
 - 1) On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches o.c. in both directions.
 - 2) Do not overcompress insulation during installation.
 - 3) Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
 - 4) Impale insulation over anchor pins and attach speed washers.
 - 5) Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
 - 6) Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
 - 7) Stagger joints between insulation layers at least 3 inches.
 - 8) Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
 - 9) Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
 - 10) For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.
- 10. Installation of Polyisocyanurate Insulation
 - a. Insulation Installation on Straight Pipes and Tubes:
 - 1) Secure each layer of insulation to pipe with tape or bands and tighten without deforming insulation materials. Orient longitudinal joints between half sections in 3- and 9-o'clock positions on the pipe.
 - 2) For insulation with factory-applied jackets with vapor barriers, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive or tape as recommended by insulation material manufacturer and seal with vapor-barrier mastic.
 - 3) All insulation shall be tightly butted and free of voids and gaps at all joints. Vapor barrier must be continuous. Before installing jacket material, install vapor-barrier system.
 - b. Insulation Installation on Pipe Flanges:
 - 1) Install preformed pipe insulation to outer diameter of pipe flange.
 - 2) Make width of insulation section same as overall width of flange and bolts, same thickness of adjacent pipe insulation, not to exceed 1-1/2-inch thickness.
 - 3) Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyisocyanurate block insulation of same thickness as pipe insulation.
 - c. Insulation Installation on Fittings and Elbows:
 - 1) Install preformed sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.
 - d. Insulation Installation on Valves and Pipe Specialties:
 - 1) Install preformed sections of polyisocyanurate insulation to valve body.
 - 2) Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 - 3) Install insulation to flanges as specified for flange insulation application.
- 11. Fire-Rated Insulation System Installation
 - a. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.
 - b. Insulate duct access panels and doors to achieve same fire rating as duct.

- c. Install firestopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Section 078413 "Penetration Firestopping."
- 12. Field-Appl Jacket Installation
 - a. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
 - 1) Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
 - 2) Embed glass cloth between two 0.062-inch- thick coats of lagging adhesive.
 - 3) Completely encapsulate insulation with coating, leaving no exposed insulation.
 - b. Where FSK jackets are indicated, install as follows:
 - 1) Draw jacket material smooth and tight.
 - 2) Install lap or joint strips with same material as jacket.
 - 3) Secure jacket to insulation with manufacturer's recommended adhesive.
 - 4) Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
 - 5) Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
 - c. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer's recommended adhesive.
 - 1) Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
 - d. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water.
 - e. Where PVDC jackets are indicated, install as follows:
 - 1) Apply three separate wraps of filament tape per insulation section to secure pipe insulation to pipe prior to installation of PVDC jacket.
 - 2) Wrap factory-presizes jackets around individual pipe insulation sections with one end overlapping the previously installed sheet. Install presized jacket with an approximate overlap at butt joint of 2 inches over the previous section. Adhere lap seal using adhesive or SSL, and then apply 1-1/4 circumferences of appropriate PVDC tape around overlapped butt joint.
 - 3) Continuous jacket can be spiral-wrapped around a length of pipe insulation. Apply adhesive or PVDC tape at overlapped spiral edge. When electing to use adhesives, refer to manufacturer's written instructions for application of adhesives along this spiral edge to maintain a permanent bond.
 - 4) Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches or less. The 33-1/2-inch-circumference limit allows for 2-inch- overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.
 - 5) Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.
 - f. Where self-adhesive outdoor jacket Type J10 is indicated, install with minimum 3-inch side laps and minimum 6-inch end laps for ductwork applications, and 3-inch side and end laps for piping applications. Apply shingle fashion to shed water over, not against laps. Do not terminate membrane on bottom of ducts; terminate membrane at 3 o'clock location on piping.
 - 1) Do not apply over wet or non-rigid insulation.
 - 2) Apply in accordance with manufacturer's requirements.
 - 3) Embed membrane applied to bottom of ducts over 24-inch wide in light continuous layer of manufacturer's adhesive applied to insulation face.

- 4) Apply membrane to bottom of insulated ducts over 36-inch wide using mechanical attachment in addition to adhesive. Install pins on 12-inch centers with rows staggered.
 - 5) Apply adhesive to areas where special adhesion requirements exist, including duct bottoms, flashings, transitions, joints, elbows, valves, tees, and other fittings.
13. Installation of Polyolefin Insulation
- a. Insulation Installation on Straight Pipes and Tubes:
 - 1) Seal split-tube longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
 - b. Insulation Installation on Pipe Flanges:
 - 1) Install pipe insulation to outer diameter of pipe flange.
 - 2) Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 - 3) Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyolefin sheet insulation of same thickness as pipe insulation.
 - 4) Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
 - c. Insulation Installation on Pipe Fittings and Elbows:
 - 1) Install mitered sections of polyolefin pipe insulation.
 - 2) Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
 - 3) Insulation Installation on Valves and Pipe Specialties:
 - 4) Install cut sections of polyolefin pipe and sheet insulation to valve body.
 - 5) Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 - d. Install insulation to flanges as specified for flange insulation application.
 - 1) Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated
- I. External Acoustical Duct Lagging System Installation
1. Board Insulation Installation for external ductwork lagging:
 - a. Provide lagging system where indicated on drawings.
 - b. For Mineral-Fiber Board lagging:
 - 1) Secure a single layer of 1 inch mineral-fiber board with minimum 4 lb/cu. ft (96 kg/cu. m) density with lagging adhesive. Provide reinforcement angles two feet on center. Mineral-fiber board shall extend edges up to seams and reinforcements.
 - c. For Gypsum lagging for duct rumble:
 - 1) Secure a single layer of 5/8 inch fire-rated gypsum board with adhesive and sheet metal screws. Provide sheet metal screws with washer in head 18 inches on center. Provide reinforcement angles two feet on center. Gypsum shall extend edges up to seams and reinforcements.
 - 2) Secure dual layers of 5/8 inch fire-rated gypsum board with adhesive and sheet metal screws. Provide sheet metal screws with washer in head 18 inches on center. Provide reinforcement angles two feet on center. Overlap layers so joints are staggered. Seal joints with sealant. Gypsum shall extend edges up to seams and reinforcements.

- 3) Secure dual layers of 5/8 inch fire-rated gypsum board with adhesive and sheet metal screws to metal stud framing. Provide 6 inches of air space around duct between the duct and metal framing to decouple the system. Overlap layers so joints are staggered. Seal joints with sealant. Gypsum shall extend edges up to seams and reinforcements.

J. Finishes

1. Duct, Equipment, and Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 painting Sections.
 - a. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
 - 1) Finish Coat Material: Interior, flat, latex-emulsion size.
2. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
3. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
4. Do not field paint aluminum or stainless-steel jackets.

3.05 FIELD QUALITY CONTROL

- A. Protect insulation materials from moisture exposure or physical damage. All glass fiber insulation that becomes wet shall be removed and replaced at no additional cost
- B. Preparation for observation of installed insulation:
- C. Prepare for observation by the Architect, insulation of pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of these observations shall be limited to four locations of straight pipe, four locations of fittings, and three locations of valves for each pipe service defined in the "Piping Insulation Schedules" Article.
- D. All insulation applications will be considered defective Work if observed selected installation reveals noncompliance with requirements.
- E. Defective work will be removed and replaced. Insulation found to have become wet will be considered defective.

3.06 FIELD TESTING

- A. Testing Agency: Contractor shall engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. Tests and Inspections:
 1. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.
- D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements. In addition to other specification requirements, all insulation that is wet or has evidence of mold will be considered defective.
- E. Defective work shall be removed and replaced. Insulation found to have become wet will be considered defective

3.07 PLUMBING SYSTEMS INSULATION SCHEDULE

- A. Insulate plumbing piping and equipment per local code requirements or local energy requirements, whichever is more stringent.

3.08 FOR DOMESTIC WATER PIPING, INSULATE ALL HORIZONTAL, VERTICAL AND IN-WALL BRANCH PIPING (DOWN WITHIN WALL, AND UP TO FIXTURE ROUGH-IN) FOR COLD, HOT, AND HOT WATER RETURN PIPING.

- A. Insulate plumbing piping and equipment as scheduled on the drawings or in accordance with the following schedule:

PLUMBING INSULATION SCHEDULE				
<u>INSULATION SPEC.</u>	<u>JACKET SPECIFICATION</u>	<u>SERVICE</u>	<u>THICKNESS</u>	<u>REMARKS</u>
F1P or F1H	ASJ Type J1	Horizontal downspout piping to and including elbows at each end of horizontal run	1"	-
FEP	None	Horizontal downspout piping to and including elbows at each end of horizontal run	1"	-
F1P or F1H	ASJ Type J1	Roof drain body and vertical pipe to horizontal pipe	1"	-
FEP	None	Roof drain body and vertical pipe to horizontal pipe	1"	-
F1P or F1H	ASJ Type J1	Soil and waste piping where indicated on drawings	1"	
FEP	None	Soil and waste piping where indicated on drawings	1"	
F1P or F1H	ASJ Type J1	Waste piping from ice machines and any waste lines receiving cold condensate for a minimum of 15' downstream of waste receptacle.	1"	
FFEP	None	Waste piping from ice machines and any waste lines receiving cold condensate for a minimum of 15' downstream of waste receptacle.	1"	
F1P or F1H	ASJ Type J1	Piping with freeze protection	1" unless greater is required in this table.	
FEP	None	Piping with freeze protection	1" unless greater is required in this table.	1-1/2" for pipes over 6"
FEP	None	Cold Tanks	1/2"	
F4P	ASJ Type J1	Hot Tanks	1"	
FEP	VM + Aluminum Type J8	Domestic Water Pumps	1"	Removable metal angle frame split access

PLUMBING INSULATION SCHEDULE				
As Indicated Above	Aluminum Type J8	Exterior Piping		
As Indicated Above	Stainless Steel Type J9	Piping exposed to view in kitchens		
F1P or F1H	ASJ Type J1	Domestic cold-water piping	1" and smaller: 0.5" insulation. Over 1" pipe: 1" insulation.	
FEP	None	Domestic cold-water piping	1" and smaller: 0.5" insulation. Over 1" pipe: 1" insulation.	
F1P or F1H	ASJ Type J1	Domestic hot water and hot water return piping	For piping up to 140°F 1" and smaller: 1" insulation Over 1" pipe: 1.5" insulation For piping over 140°F 1" and smaller: 1.5" insulation Over 1" pipe: 2" insulation	
FEP	None	Domestic hot water and hot water return piping	For piping up to 140°F 1" and smaller: 1" insulation Over 1" pipe: 1.5" insulation For piping over 140°F 1" and smaller: 1.5" insulation Over 1" pipe: 2" insulation	

- B. Indoor, Field-Applied Jackets
 - 1. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- C. Outdoor, Field-Applied Jacket Schedule
 - 1. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- D. Underground, Field-Installed Insulation Jacket
 - 1. For underground direct-buried piping applications, install underground direct-buried type J11 jacket over insulation material.
- E. ADA Undersink Insulation

1. For all lavatory and front-approach sinks designated as ADA accessible on the architectural documents, install protective shields or under sink guards. Coordinate with architect as to which if not identified on the drawings.

3.09 HVAC PIPING SYSTEMS INSULATION SCHEDULE

- A. Acceptable pipe and tube insulation materials and thicknesses are identified in the schedules below for each piping system and pipe size range.
 1. Insulate return piping same as supply piping, for given liquid.
 2. Insulate steam condensate same as scheduled for steam supply of same pressure.
 3. Insulate steam condensate pump discharge piping same as scheduled for Steam, 15 psig and less.
 4. Continuous- and Bottom- Boiler Blowdown piping, Boiler Feedwater piping, and piping to and from Boiler Economizers, shall be insulated same as Steam of same pressure as boiler rating.
- B. Piping Insulation System Schedule

PIPING INSULATION SYSTEM SCHEDULE						
<u>Insulation System</u>	<u>Piping</u>		<u>Fittngs, Valves</u>		<u>MICA Plate #</u>	<u>Additional Requirements</u>
	<u>Insulation</u>	<u>Jacket</u>	<u>Insulation</u>	<u>Jacket</u>		
IS-P1						
1-1/4" and larger	F1H	J1	F4AH	J3	1-500A, 2-500, 2-530	
1" and smaller	F1H	J1	F1H	J1	1-500A, 2-110, 2-130	
Exposed to view, Food Service areas	F1H	J3	F4AH	J3	1-500B, 2-500, 2-530	
Exposed to view, Sterile areas	F1H	J9	F4AH	J9	1-400B, 2-400, 2-425	
In Mechanical Rooms	F1H	J3	F4AH	J3	1-500A, 2-500, 2-530	
IS-P2						
All sizes	F1H	J1	F1H	J8	1-500A, 2-400, 2-425	
In Mech Rooms, below 7 ft AFF	F1H	J8	F1H	J8	1-400B, 2-400, 2-425	
IS-P3	F1H	J1+J10	F4AH	J3+J10		
IS-P4	PISOH	J10	PISOH	J10		
IS-P5	CS1H	J8	CS1H	J8	1-400B, 2-400, 2-425	
IS-P5A	MWH	J8	MWH	J8		
IS-P6	CS2H	J8	CS2H	J8	1-400B, 2-400, 2-425	

PIPING INSULATION SYSTEM SCHEDULE						
IS-P7						
4" and smaller	FE1H		FE1H		1-200	
5" and smaller	FE2H		FE2H		1-200	
Exposed to view, Food Service areas	FE1H or FE2H	J3	FE1H or FE2H	J3	1-500B, 2-500, 2-530	
Exposed to view, Sterile areas	FE1H or FE2H	J9	FE1H or FE2H	J9	1-400B, 2-400, 2-425	
IS-P8	PISOH		PISOH			

C. Piping Insulation Application Schedule:

<u>PIPING INSULATION APPLICATION SCHEDULE</u>						
		<u>Pipe Size</u>				
<u>Fluid</u>	<u>Insulation Spec</u>	1" and smaller	1-1/2" - 2"	2-1/2" - 4"	5"-8"	10" and larger
		<u>Insulation Thickness</u>				
<u>PIPING WITHIN CONDITIONED SPACE</u>						
Chilled Water, 40 deg F and colder	IS-P8	1-1/2"	1-1/2"	1-1/2"	1-1/2"	1-1/2"
Chilled Water, 41 deg F to 50 deg F	IS-P1	1"	1"	1-1/2"	1-1/2"	1-1/2"
Chilled Water, 51 deg F to 70 deg F	IS-P1	1"	1"	1"	1"	1"
Condenser Water, 41 deg F to 50 deg F	IS-P1	1"	1"	1-1/2"	1-1/2"	1-1/2"
Condenser Water, 51 deg F to 70 deg F	IS-P1	1"	1"	1"	1"	1"
Glycol-Water, 40 deg F and	IS-P1	1-1/2"	1-1/2"	1-1/2"	1-1/2"	1-1/2"

PIPING INSULATION APPLICATION SCHEDULE						
colder						
Glycol-Water, 41 deg F to 50 deg F	IS-P1	1"	1"	1-1/2"	1-1/2"	1-1/2"
Glycol-Water, 51 deg F to 70 deg F	IS-P1	1"	1"	1"	1"	1"
Glycol-Water, 141 deg F to 200 deg F	IS-P1	1-1/2"	2"	2"	2"	2"
Glycol-Water, 201 deg F to 250 deg F	IS-P1	2-1/2"	2-1/2"	3"	3"	3"
Heating Hot Water, 106 deg F to 140 deg F	IS-P1	1"	1-1/2"	1-1/2"	1-1/2"	1-1/2"
Heating Hot Water, 141 deg F to 200 deg F	IS-P1	1-1/2"	2"	2"	2"	2"
Heating Hot Water, 201 deg F to 250 deg F	IS-P1	2-1/2"	2-1/2"	3"	3"	3"
Refrigerant Suction	IS-P7	1-1/2"	1-1/2"	1-1/2"	1-1/2"	1-1/2"
Refrigerant Liquid	None					
Refrigerant Hot gas by-pass, up to 7' AFF	IS-P7+J8	1-1/2"	1-1/2"	1-1/2"	1-1/2"	1-1/2"
Steam, 15 psig and less	IS-P1	2-1/2"	2-1/2"	3"	3"	3"
Steam, 16 psig-50 psig	IS-P2	3"	4"	4"	4-1/2"	4-1/2"

PIPING INSULATION APPLICATION SCHEDULE						
Steam, 51 psig-120 psig	IS-P3	4"	4-1/2"	4-1/2"	5"	5"
Steam, over 120 psig	IS-P2	5"	5"	5"	5"	5"
Generator Exhaust Piping (Oil)	IS-P5 or IS-P5A	3"	3"	3"	3"	3"
Generator Exhaust Piping (Gas)	IS-P6	3"	3"	3"	3"	3"
Hot Service Drains and Vents (>140 deg F)	IS-P2	1"	1"	1"	1"	1"
MRI Cryogen Quench Vent	IS-P1				1-1/2"	1-1/2"
Cold Condensate Drains (>60 deg F)	IS-P7	1"	1"	1"	1"	1"
PIPING INSULATION APPLICATION SCHEDULE						
Pipe Size						
<u>Fluid</u>	<u>Insulation Spec</u>	1" and smaller	1-1/2" - 2"	2-1/2" - 4"	5"-8"	10" and larger
Insulation Thickness						
PIPING IN UN-CONDITIONED SPACE						
Chilled Water, 40 deg F and colder	IS-P8	1-1/2"	1-1/2"	1-1/2"	2"	2"
Chilled Water, 41 deg F to 50 deg F	IS-P1	1-1/2"	1-1/2"	1-1/2"	2"	2"
Chilled Water, 51 deg F to 70 deg F	IS-P1	1-1/2"	1-1/2"	1-1/2"	1-1/2"	1-1/2"
Condenser Water, 41 deg F to 50 deg F	IS-P1	2"	2"	2"	2"	2"

PIPING INSULATION APPLICATION SCHEDULE						
Condenser Water, 51 deg F to 70 deg F	IS-P1	1-1/2"	1-1/2"	1-1/2"	1-1/2"	1-1/2"
Glycol-Water, 40 deg F and colder	IS-P1	1-1/2"	1-1/2"	1-1/2"	2"	2"
Glycol-Water, 41 deg F to 50 deg F	IS-P1	1-1/2"	1-1/2"	1-1/2"	2"	2"
Glycol-Water, 51 deg F to 60 deg F	IS-P1	1-1/2"	1-1/2"	1-1/2"	1-1/2"	1-1/2"
Glycol-Water, 61 deg F to 70 deg F	IS-P1	1-1/2"	1-1/2"	1-1/2"	1-1/2"	1-1/2"
Glycol-Water, 71 deg F to 105 deg F	IS-P1	1-1/2"	1-1/2"	1-1/2"	1-1/2"	1-1/2"
Glycol-Water, 106 deg F to 140 deg F	IS-P1	1-1/2"	1-1/2"	1-1/2"	1-1/2"	1-1/2"
Glycol-Water, 141 deg F to 200 deg F	IS-P1	2"	2"	2-1/2"	2-1/2"	2-1/2"
Glycol-Water, 201 deg F to 250 deg F	IS-P1	3"	3"	4"	4"	4"
Heating Hot Water, 106 deg F to 140 deg F	IS-P1	1"	1-1/2"	1-1/2"	1-1/2"	1-1/2"
Heating Hot Water, 141 deg F to	IS-P1	1-1/2"	2"	2-1/2"	2-1/2"	2-1/2"

PIPING INSULATION APPLICATION SCHEDULE						
200 deg F Heating Hot Water, 201 deg F to 250 deg F	IS-P1	3"	3"	3"	3"	3"
Refrigerant Suction	IS-P7+J8	1-1/2"	1-1/2"	1-1/2"	1-1/2"	1-1/2"
Refrigerant Liquid	None					
Refrigerant Hot gas by- pass	IS-P7+J8	1-1/2"	1-1/2"	1-1/2"	1-1/2"	1-1/2"
Generator Exhaust Piping (Oil)	IS-P5+J8 or IS-P5A+J8	3"	3"	3"	3"	3"
Generator Exhaust Piping (Gas)	IS-P6+J8	3"	3"	3"	3"	3"

3.10 HVAC MISCELLANEOUS INSULATION REQUIREMENTS

- A. Boiler Breeching and connector insulation for non-Factory Fabricated breechings and stacks shall be [one of] the following:
 1. Calcium Silicate: 4 inches thick.
 2. Glass Fiber Rigid Board – Elevated Temperature – Type F6H: 4 inchesthick
- B. HVAC Equipment Insulation Schedule
 1. Insulation materials and thicknesses are identified below. Insulate indoor and outdoor equipment in schedule below that is not factory insulated.
 2. Cold Equipment: Insulate the following equipment with insulation Type FE2H, 2-inch thickness or, insulation Type F3H, 2-inch thickness:
 - a. Chiller Evaporator, water box and heads
 - b. Chilled Water Pumps
 - c. Plate and Frame Heat Exchangers
 - d. Condenser Water Pumps
 - e. Indoor Condenser Water Sump
 - f. Make-up Water Storage Tank
 - g. Chilled Water Storage Tank
 - h. Air Separators
 3. Expansion Tank
 - a. Pot Feeders
 - b. Side Stream Filters
 - c. Basket Strainers
 4. Hot Equipment: Insulate the following equipment with insulation Type F3H, 3-inch thickness or, insulation Type F4H, 3-inch thickness and Type J8 aluminum jacket:
 - a. Blowdown Separators
 - b. Deaerators
 - c. Feedwater Tanks

- d. Condensate Return Tanks
- e. Flash Tanks
- 5. Hot Equipment: Insulate the following equipment with insulation Type F3H, 2-inch thickness or, insulation Type F4H, 2-inch thickness and Type J8 aluminum jacket:
 - a. Air Separators
 - b. Expansion Tanks
 - c. Pot Feeders
 - d. In-line hot water pumps
 - e. Alternate insulation: Removable, re-usable insulating jacket.
- 6. Hot Equipment: Insulate the following equipment with insulation Type F6H (F7H on irregular surfaces) 4-inch thickness, and Type J8 aluminum jacket or, insulation Type CS1H with glass cloth jacket, 4-inc thickness:
 - a. Shell and Tube Heat Exchangers
- 7. Hot Equipment: Insulate the following equipment with insulation Type F6H or Type F7H and Type J8 aluminum jacket, 2-inch thickness:
 - a. Plate and Frame Heat Exchangers
- C. HVAC Duct and Plenum Insulation Schedule
 - 1. Insulate duct in accordance with the following schedule.
 - a. "Concealed" means "concealed from view" and "Exposed" means "exposed to view."
 - b. In equipment rooms, insulate all supply ductwork, all return ductwork, all exhaust duct work from exhaust damper to exhaust louver and supply unit mixed air plenum as specified in the duct and plenum insulation schedule.
 - c. For concealed ductwork in unconditioned space, follow the requirements for exposed ductwork in unconditioned space in the Duct and Plenum Insulation Schedule.
 - d. Omit insulation on round within conditioned space indoor exposed supply duct.

DUCT AND PLENUM INSULATION SCHEDULE													
		CONCEALED			EXPOSED								
		WITHIN AIR CONDITIONED SPACE			WITHIN AIR CONDITIONED SPACE			IN MECH ROOM, 60 DEG F-105 DEG F			IN UNCONDITIONED SPACE OR OUTDOORS		
SERVIC E	DUCT SHAPE	INSU L. TYP E	THICK -NESS	PCF	INSU L. TYP E	THICK -NESS	PCF	INSU L. TYP E	THICK -NESS	PCF	INSU L. TYP E	THICK -NESS	PCF
SUPPL Y	RECTA NG.	F9H, J2	1-1/2"	0.75	F5H, J2	1-1/2"	3.0	F5H, J2	2"	6.0	F5H, J2+J 10	2"	6.0
	ROUND	F9H, J2	1-1/2"	0.75	F9H, J2	1-1/2"	1.0	F9H, J2	2"	1.5	F9H, J2+J 10	2"	1.5
RETUR N	RECTA NG.	N/A	N/A	N/A	N/A	N/A	N/A	F5H, J2	1-1/2"	6.0	F5H, J2+J 10	1-1/2"	6.0
	ROUND	N/A	N/A	N/A	N/A	N/A	N/A	F9H, J2	1-1/2"	1.0	F9H, J2+J 10	1-1/2"	1.5
EXHAU ST	RECTA NG.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

DUCT AND PLENUM INSULATION SCHEDULE													
	ROUND	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
EXHAUST AIR FROM EXHAUST DAMPER TO LOUVER	RECTANG.	F9H, J2	2"	0.75	F5H, J2	2"	3	F5H, J2	1-1/2"	6	N/A	N/A	N/A
	ROUND	F9H, J2	2"	0.75	F9H, J2	2"	1	F9H, J2	1-1/2"	1	N/A	N/A	N/A
KITCHEN EXHAUST (2-HOUR MINIMUM)	RECTANG.	FRB-2	2 LAYERS @ 1-1/2"	6.0	FRB-2	2 LAYERS @ 1-1/2"	6.0	FRB-2	2 LAYERS @ 1-1/2"	6.0	FRB-2	2 LAYERS @ 1-1/2"	6.0
	ROUND	FRB-2	2 LAYERS @ 1-1/2"	6.0	FRB-2	2 LAYERS @ 1-1/2"	6.0	FRB-2	2 LAYERS @ 1-1/2"	6.0	FRB-2	2 LAYERS @ 1-1/2"	6.0
KITCHEN EXHAUST ON THE ROOF	RECTANG.	MWH	2"	4 WITH VENTURE CLAD JACKET	MWH	2"	4 WITH VENTURE CLAD JACKET	MWH	2"	4 WITH VENTURE CLAD JACKET	MWH	2"	4 WITH VENTURE CLAD JACKET
	ROUND	MWH	2"	4 WITH VENTURE CLAD JACKET	MWH	2"	4 WITH VENTURE CLAD JACKET	MWH	2"	4 WITH VENTURE CLAD JACKET	MWH	2"	4 WITH VENTURE CLAD JACKET
OUTDOOR AIR	RECTANG.	F9H, J2	2"	0.75	F5H, J2	2"	3.0	F5H, J2	1-1/2"	6.0	N/A	N/A	N/A
	ROUND	F9H, J2	2"	0.75	F9H, J2	2"	1.0	F9H, J2	1-1/2"	1.0	N/A	N/A	N/A

END OF SECTION

**SECTION 20 08 00
MECHANICAL COMMISSIONING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Visual inspection of the equipment and installation.
- B. Review of the certification requirement, and
- C. Functional tests of the system and controls
- D. Commissioning Process
- E. Commissioning Responsibilities
- F. Test equipment.

1.02 GENERAL REFERENCES

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.
- B. Division 20, including all Common Mechanical Requirements in Section 20 00 00, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.
- C. Acceptance requirements specify targeted inspection procedures and functional/performance test procedures that serve to determine whether specific building components, equipment, systems, and interfaces between systems conform to the criteria set forth in the Standards, and to the applicable construction documents (plans and specifications). Acceptance requirements ensure code compliance and promote optimization of system efficiency and performance.
- D. The Licensed Installation Contractor shall act as the Responsible Person. The acceptance testing shall be performed and documented by either the Responsible Person or a Field Technician. The Field Technician and/or the Responsible Person may be different for each acceptance test. The acceptance requirement process must address the following:
 - 1. Review the Construction Documents to verify that sensor locations, devices and control sequences are properly documented.
 - 2. Review the installation, and complete the required acceptance testing.
 - 3. Certify the acceptance test results on the Certificate of Acceptance.
 - 4. Submit the Certificate to the Building Department prior to receiving a final occupancy permit.

1.03 REFERENCE STANDARDS

- A. The following referenced Industry Standards and Project Manual Specification Sections shall be used by the Commissioning Authority for developing the commissioning plan and all forms:
 - 1. ASHRAE Guideline 0-2013, The Commissioning Process.
 - 2. ASHRAE Guideline 1.1-2007, HVAC&R Technical Requirements for The Commissioning Process.
 - 3. ASHRAE Guideline 4-2008, Preparation of Operation and Maintenance Documentation for Building Systems.
 - 4. Building Commissioning Guidelines, 2nd Edition, Bonneville Power Administration.
 - 5. NEBB Procedural Standards for Building Systems Commissioning, 2009 - 3rd Edition.
 - 6. PECI Commissioning Guidelines and Templates

1.04 ABBREVIATIONS AND ACRONYMS

- A. Abbreviations: The following are common abbreviations used in the Project Manual and in the commissioning plan.
 - 1. CxA - Commissioning Authority

2. CC - Controls Contractor
3. CM - Construction Manager
4. Cx - Commissioning
5. Cx Plan - Commissioning Plan Document
6. EC - Electrical Contractor
7. MC - Mechanical Contractor
8. PFT - Pre-Functional Checklist
9. PM - Project Manager (of the owner)
10. Subs - Subcontractors to CM
11. TAB - Test, Adjusting & Balancing Contractor

1.05 DEFINITIONS

- A. Acceptance Phase: Phase of construction after startup and initial checkout when functional performance tests, O&M documentation review and training occur.
- B. Approval: Acceptance that a piece of equipment or system has been properly installed and is functioning in the tested modes according to the contract documents.
- C. Architect / Engineer (A/E): The prime consultant (Architect) and sub-consultants who comprise the design team, generally the mechanical engineer and the electrical engineer.
- D. Basis of Design (BoD): The basis of design is the documentation of the primary thought processes and assumptions behind design decisions that were made to meet the design intent. The basis of design describes the systems, components, conditions and methods chosen to meet the intent. Some reiterating of the design intent may be included.
- E. Commissioning: A systematic process of ensuring that all building systems perform interactively according to the contract documents, design intent and the owner's operational needs through the construction, acceptance and the warranty period with actual verification of performance. The commissioning process encompasses and coordinates the traditionally separate functions of system documentation, equipment startup, control system calibration, testing and balancing, performance testing and training. Commissioning during the construction phase is intended to achieve the following specific objectives in accordance with the contract documents:
 1. Verify that applicable equipment and systems are installed in accordance with the contract documents, manufacturer's recommendations and to industry accepted minimum standards and that they receive adequate operational checkout by installing contractors. The details on the drawings will take precedence over industry accepted minimum standards, unless the specifications make specific references (i.e. ASME 31.1 for piping).
 2. Verify and document proper performance of equipment and systems.
 3. Verify the testing, adjusting and balancing report.
 - a. The commissioning process does not take away from or reduce the responsibility of the system designers or installing contractors to provide a finished and fully functioning product.
- F. Commissioning Authority: (CxA): The CxA directs and coordinates the day-to-day commissioning activities. The CxA does not take an oversight role like the CM. The CxA is part of the Architect/Engineer's team or shall report directly to the owner.
- G. Commissioning Plan: An overall plan, developed before or after bidding that provides the structure, schedule and coordination planning for the commissioning process.
- H. Contract Documents: The documents binding on parties involved in the construction of this project (drawings, specifications, change orders, amendments, contracts, Cx Plan, etc.).
- I. Control System: The central building energy management control system.

- J. Construction Manager (CM): Generally refers to all the CM's subcontractors as well. Also referred to as the contractor, in some contexts. The CM is hired by the owner and is contracted to oversee the fulfillment of all requirements of the contract documents.
- K. Data logging: Monitoring flows, currents, status, pressures, etc. of equipment using stand-alone data loggers separate from the control system.
- L. Deferred Functional Tests: FT's that are performed later, after substantial completion, due to partial occupancy, equipment, seasonal requirements, design or other site conditions that disallow the test from being performed.
- M. Deficiency (also referred to as "Identified Issue"): A condition in the installation or function of a component, piece of equipment or system that is not in compliance with the contract documents (that is, does not perform properly or is not complying with the design intent).
- N. Design Intent: A dynamic document that provides the explanation of the ideas, concepts and criteria that are considered to be very important to the owner. It is initially the outcome of the programming and conceptual design phases.
- O. Design Narrative or Design Documentation: Sections of either the Design Intent or Basis of Design.
- P. Factory Testing: Testing of equipment at the factory with an owner's representative present.
- Q. Functional Test (FT): Test of the dynamic function and operation of equipment and systems using manual (direct observation) or monitoring methods. Functional testing is the dynamic testing of systems (rather than just components) under full operation (e.g., the chiller pump is tested interactively with the chiller functions to see if the pump ramps up and down to maintain the differential pressure setpoint). Systems are tested under various modes, such as during low cooling or heating loads, high loads, component failures, unoccupied, varying outside air temperatures, fire alarm, power failure, etc. The systems are run through all the control system's sequences of operation and components are verified to be responding as the sequences state. Traditional air or water test and balancing (TAB) is not functional testing, in the commissioning sense of the word. TAB's primary work is setting up the system flows and pressures as specified, while functional testing is verifying what has already been set up. The commissioning authority develops the functional test procedures in a sequential written form, coordinates, oversees and documents the actual testing, which is usually performed by the installing contractor or vendor. FT's are performed after prefunctional checklists and start-up are complete.
- R. Indirect Indicators: Indicators of a response or condition, such as a reading from a control system screen reporting a damper to be 100 percent closed.
- S. Manual Test: Using hand-held instruments, immediate control system readouts or direct observation to verify performance (contrasted to analyzing monitored data taken over time to make the "observation").
- T. Monitoring: The recording of parameters (flow, current, status, pressure, etc.) of equipment operation using data loggers or the trending capabilities of control systems.
- U. Non-Compliance: See Deficiency.
- V. Non-Conformance: See Deficiency.
- W. Over-written Value: Writing over a sensor value in the control system to see the response of a system (e.g., changing the outside air temperature value from 50 to 75 degrees F to verify economizer operation). See also "Simulated Signal."
- X. Owner-Contracted Tests: Tests paid for by the owner outside the CM's contract and for which the CxA does not oversee. These tests will not be repeated during functional tests if properly documented.

- Y. Phased Commissioning: Commissioning that is completed in phases (by floors, for example) due to the size of the structure or other scheduling issues, in order minimize the total construction time.
- Z. Pre-functional Checklists (PFC's): A list of items to inspect and elementary component tests to conduct to verify proper installation of equipment, provided by the CxA to the CM and Sub.
Pre-functional checklists are primarily static inspections and procedures to prepare the equipment or system for initial operation (e.g., belt tension, oil levels OK, labels affixed, gages in place, sensors calibrated, etc.). However, some pre-functional checklist items entail simple testing of the function of a component, a piece of equipment or system (such as measuring the voltage imbalance on a three-phase pump motor of a chiller system). The word pre-functional refers to before functional testing. Pre-functional checklists augment and are combined with the manufacturer's start-up checklist. Even without a commissioning process, contractors typically perform some, if not many, of the pre-functional checklist items a commissioning authority will recommend. However, few contractors document in writing the execution of these checklist items. Therefore, for most equipment, the contractors execute the checklists on their own. The CxA only requires that the procedures be documented in writing, and does not witness much of the pre-functional check listing, except for larger or more critical pieces of equipment.
- AA. Project Manager (PM): The individual employed by the owner to be responsible for the overall management and oversight of the Project.
- BB. Sampling: Functionally testing only a fraction of the total number of identical or near identical pieces of equipment.
- CC. Seasonal Performance Tests: FT's that are deferred until the system(s) will experience conditions closer to their design conditions.
- DD. Simulated Condition: Condition that is created for the purpose of testing the response of a system (e.g., applying a hair blower to a space sensor to see the response in a VAV box).
- EE. Simulated Signal: Disconnecting a sensor and using a signal generator to send an amperage, resistance or pressure to the transducer and DDC system to simulate a sensor value.
- FF. Startup: The initial starting or activating of dynamic equipment, including executing pre-functional checklists.
- GG. Subs: The subcontractors to the CM who provide and install building components and systems.
- HH. Test Procedures: The step-by-step process that must be executed to fulfill the test requirements. The test procedures are developed by the CxA.
- II. Test Requirements: Requirements specifying what modes and functions, etc. shall be tested. The test requirements are not the detailed test procedures.
- JJ. Trending: Monitoring using the building control system.
- KK. Vendor: Supplier of equipment.
- LL. Warranty Period: Warranty period for entire project, including equipment components.
Warranty begins at substantial completion and extends for a period indicated in the contract documents and accepted submittals. As may be amended by owner requirements (i.e. beneficial use of the chiller plant).

1.06 SUBMITTALS

- A. Action Submittals
 - 1. Submit under provisions of Divisions 20, 21, 22, 23, 26, and 28.
 - 2. The CxA will provide appropriate contractors with a specific request for the type of submittal documentation the CxA requires to facilitate the commissioning work. These requests will be integrated into the normal submittal process and protocol of the construction team. At a minimum, the request will include the manufacturer and model number, the manufacturer's printed installation and detailed start-up procedures, full

sequences of operation (as applicable), O&M data, performance data, any performance test procedures, control drawings (as applicable) and details of owner contracted tests. In addition, the installation and checkout materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the Commissioning Authority.

3. The CxA may request additional design narrative from the A/E and Controls Contractor, depending on the completeness of the design intent documentation and sequences provided with the Specifications.
4. These submittals to the CxA do not constitute compliance for O&M manual documentation. The O&M manuals are the responsibility of the contractor.
5. Required Embodied Carbon Submittals: All products which satisfy one of the following criteria will require an Embodied Carbon Submittal:
 - a. The product is a 'Major' piece of equipment
 - b. The product contains refrigerant
 - c. The cost of a group of products serving a given function constitutes 5% or greater of the sub-contractor's budget, excluding labor.
6. Embodied Carbon Submittals
 - a. Order of Preferred Submittals: For products which require an embodied carbon submittal (described above), one of the following must be provided. The submittal must be that with the highest preference available. The order preference, from highest to lowest is:
 - 1) Product Specific, Facility Specific EPD
 - 2) Product Specific EPD
 - 3) Industry Average EPD
 - 4) TM65 Manufacturer Form with Mid-Level Calculation data
 - 5) TM65 Manufacturer Form with Basic Calculation data
- B. Informational Submittals
- C. Closeout Submittals
- D. Operation and Maintenance Materials
- E. Record Documents
 1. Documentation of Commissioning Process:
 - a. The CxA is responsible to compile, and organize the following commissioning data, by system, into indexed and bound for delivery to the owner. The commissioning record shall include 4 main sections:
 - 1) Commissioning Plan
 - 2) Final Commissioning Report
 - 3) Commissioning Testing Record
 - 4) Issues and Deficiencies Record
 - b. The Final Commissioning Report shall include:
 - 1) Executive Summary
 - 2) List of participants and roles
 - 3) Brief building description
 - 4) Overview of commissioning and testing scope
 - 5) General description of testing and verification methods.
 - c. The Commissioning Testing Record shall include:
 - 1) Completed pre-functional checklists and system startup forms
 - 2) Completed functional testing forms for each system
 - d. The Cx Issues Tracking List shall include:
 - 1) All open items listing
 - 2) All closed items listing

1.07 COORDINATION

- A. Commissioning Team: The members of the commissioning team consist of the following:
 - 1. Owner's project manager (PM);
 - 2. Commissioning authority (CxA);
 - 3. Designee of the owner's construction management firm (CM);
 - 4. Architect and/or design engineers (A/E) (particularly the mechanical engineer);
 - 5. Mechanical contractor (MC);
 - 6. Electrical contractor (EC);
 - 7. Representative of TAB subcontractor (TAB);
 - 8. Controls contractor (CC);
 - 9. Any other installing subcontractors or suppliers of equipment;
 - 10. The building or plant operator/engineer.
- B. Management: The CxA is hired by the owner. The CxA directs and coordinates the commissioning activities and reports to the owner, A/E, and CM. All members work together to fulfill their respective contracted responsibilities and to meet the objectives of the contract documents.
- C. Scheduling: The CxA will work with the CM and associated contractors according to established protocols to schedule the commissioning activities. The CxA will provide sufficient notice to the CM and contractors for scheduling commissioning activities. The CM will integrate all commissioning activities into the master schedule. All parties will address scheduling problems and make necessary notifications in a timely manner in order to expedite the commissioning process.
 - 1. The CxA will provide the initial schedule of commissioning milestones at the commissioning kick-off meeting. The "Commissioning Plan" provides a format for this schedule. As construction progresses more detailed schedules are developed by the CxA in coordination with the Commissioning Team.

1.08 SUMMARY DESCRIPTION

- A. This Section includes Commissioning of Building Systems incorporating the following:
 - 1. HVAC Systems and Associated Controls.
 - 2. Plumbing Systems and Associated Controls.
 - 3. Fire Protection and Fire Alarm Systems.
 - 4. General requirements for coordinating and scheduling commissioning.
 - 5. Commissioning meetings.
 - 6. Commissioning reports.
 - 7. Use of test equipment, instrumentation, and tools for commissioning.
 - 8. Construction checklists, including, but not limited to, installation checks, startup, performance tests, and performance test demonstration.
 - 9. Commissioning tests and commissioning test demonstration.
 - 10. Adjusting, verifying, and documenting identified systems and assemblies.
- B. Certain building systems on this Project are to be commissioned using a team approach lead by the designated Commissioning Authority (CxA). The intent of this commissioning program is to provide documentation, testing, verification, and training facilitation to help insure that the Project satisfies the needs of the Owner and the designer's intent. The scope of the commissioning program includes:
 - 1. Start up and testing of specified equipment and systems in accordance with the approved and updated Commissioning Authority commissioning plan, Field Installation Verification, Operational Performance Test, and Functional Performance Test approved forms.
 - 2. Identification of and documentation of equipment and system deficiencies and normal operating parameters.
 - 3. Corrective actions and acceptance of corrected equipment and systems.
 - 4. Review Operation and Maintenance manuals for completeness.
 - 5. Preventative maintenance equipment and system data collection.

6. Verify and Document Equipment and systems use and maintenance training is completed.
- C. The Commissioning Authority (CxA) shall furnish labor and materials to facilitate, accomplish, and coordinate Building Commissioning as specified herein.
- D. Schedule of Values: Contractor will delineate the cost of supporting the Commissioning Authority activities as a separate line item on their schedule of values.
- E. Project Schedule: Contractor shall include the Commissioning Authority systems commissioning support in the total Project schedule as required by other specification Sections.

1.09 COMMISSIONING PROCESS

- A. Commissioning Plan: The "Commissioning Plan" provides guidance in the execution of the commissioning process. After the initial commissioning coordination meeting, the CxA will update the plan, which will continue to evolve as the project progresses.
- B. Commissioning Process: The following narrative provides a brief overview of the typical commissioning tasks during construction and the general order in which they occur.
 1. Commissioning during construction begins with a kick-off meeting conducted by the CxA where the commissioning process is reviewed with the commissioning team members.
 2. Additional meetings will be required throughout construction, scheduled by the CxA with necessary parties attending, to plan, scope, coordinate, and schedule future activities and resolve problems.
 3. Equipment documentation is submitted to the CxA during normal submittals, including detailed start-up procedures.
 4. CxA works with the CM and Subs in developing startup plans and pre-functional documentation formats.
 5. In general, the checkout and performance verification proceeds from simple to complex, from component level to equipment to systems and intersystem levels with pre-functional checklists being completed before functional testing.
 6. The Subs, under the direction of the CM, execute and document the pre-functional checklists and perform startup and initial checkout. The CxA documents that the checklists and startup were completed according to the approved plans. This may include the CxA witnessing start-up of selected equipment.
 7. The CxA develops specific equipment and system functional test procedures. The CM and Subs review the procedures and provide comments to CxA.
 8. The procedures are executed by the Subs, under the direction of the CM, and documented by the CxA.
 9. Items of non-compliance in material, installation or setup are corrected and the system retested.
 10. Commissioning is intended to be completed before substantial completion.

1.10 COMMISSIONING RESPONSIBILITIES

- A. The responsibilities of various parties in the commissioning process are provided in this section. Additional responsibilities of the Mechanical, Temperature Controls and TAB Contractors are in Division 23. Additional responsibilities of the Plumbing Contractor are in Division 22 and for the Electrical Contractor in Division 26. The services of the Project Manager, Architect, Mechanical and Electrical Designers/Engineers, and Commissioning Authority are not provided for in the contract and CM is not responsible for providing their services. Their responsibilities of the PM, A/E and CxA are listed here to clarify the commissioning process.
- B. All Parties:
 1. Follow the commissioning plan.
 2. Attend the commissioning kick-off meeting and additional meetings, as necessary.
- C. Architect (or A/E):
 1. Construction and Acceptance Phase:
 - a. The CM coordinates with the CxA contract for the owner.

- b. Attend the commissioning kick-off meeting and selected commissioning team meetings.
 - c. Perform normal submittal review, construction observation, record drawing preparation, O&M manual preparation, etc., as contracted.
 - d. Accept and review request made by the CxA for supplemental design narrative documentation.
 - e. Coordinate resolution of system deficiencies identified during commissioning, according to the contract documents.
 - 2. Warranty Period:
 - a. Coordinate resolution of design non-conformance and design deficiencies identified during warranty-period commissioning.
- D. Mechanical and Electrical Designers/Engineers (of the A/E):
 - 1. Construction and Acceptance Phase:
 - a. Perform normal submittal review, construction observation, record drawing preparation, etc., as contracted with the Architect. One (1) site observation at discretion of the A/E should be completed just prior to system startup.
 - b. Accept and review report made by the CxA for supplemental design narrative and sequence documentation. The designers shall assist (along with the contractors) in clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.
 - c. Attend commissioning kick-off meeting and other selected commissioning team meetings per A/E contract.
 - d. Participate in the resolution of system deficiencies identified during commissioning, according to the contract documents.
 - e. Review the final copies of the O&M manuals and submit to owner.
 - f. From the contractor's red-line drawings, edit and update one-line diagrams developed as part of the design narrative documentation and those provided by the vendor as shop drawings for the chilled and hot water, domestic water, steam and condensate systems; supply, return and exhaust air systems as outlined in A/E contract. Provide these drawings, electronically, to the CxA. Provide electronic versions of the as-built sequences of operations, control drawings and original set points.
 - g. Provide system overviews at the training sessions for the owner's personnel.
 - 2. Warranty Period:
 - a. Participate in the resolution of non-compliance, non-conformance and design deficiencies identified during warranty-period commissioning.
- E. Commissioning Authority (CxA):
 - 1. The CxA is not responsible for design concept, design criteria, compliance with codes, design or general construction scheduling, cost estimating, or construction management. The CxA may assist with problem solving, non-conformance issues or deficiencies, but ultimately that responsibility resides with the CM and the A/E. The primary role of the CxA is to develop and coordinate the execution of a testing plan, observe and document performance to verify that systems are functioning in accordance with the contract documents. The contractors and subcontractors shall provide all tools or the use of tools to start, check out and functionally test equipment and systems, except for specified testing with portable data-loggers, which shall be supplied and installed by the CxA.
 - 2. Design Phase:
 - a. Develop and utilize a commissioning plan.
 - b. Incorporate commissioning requirements into the contract documents.
 - 3. Construction and Acceptance Phase:

- a. Coordinate and direct the commissioning activities in a logical, sequential and efficient manner using consistent protocols and forms, centralized documentation, clear and regular communications and consult with all necessary parties, frequently updated timelines and schedules and provide technical expertise.
 - b. Coordinate the commissioning work and, with the CM, verify that commissioning activities are being scheduled into the master schedule.
 - c. Update the commissioning plan as the project progresses.
 - d. Plan and conduct a commissioning kick-off meeting and other commissioning meetings as required.
 - e. Request and review additional information required to perform commissioning tasks, including O&M materials, contractor start-up and checkout procedures. Review contractor's shop drawings and submittals for items being commissioned and provide comments back to CM.
 - f. Before startup, gather and review the current control sequences and interlocks and work with contractors and design engineers until sufficient clarity has been obtained, in writing, to be able to write detailed testing procedures.
 - g. Perform site visits, as necessary, to observe component and system installations.
 - h. Write the pre-functional checklists for commissioned equipment. Pre-functional checklists are to be completed by Subs.
 - i. Review and approve completed pre-functional checklists.
 - j. Review completed air and water balancing reports. Verify approximately 10-15% of the TAB contractors air balancing work through physical measurements.
 - k. Write the functional test procedures for commissioned equipment and systems with assistance from installing contractors.
 - l. Coordinate and witness functional tests on commissioned systems. Review controls graphics for completeness and accuracy.
 - m. Analyze sufficient functional performance trend logs and monitoring data to verify performance.
 - n. Assist in scheduling Owner's maintenance personnel, as required, to attend training classes conducted by the contractors. Collect sign-in sheets and training records to include in final Commissioning Record Book. Commissioning agent does not need to attend training sessions, demonstration of facilities or warranty orientation.
 - o. Maintain issue's tracking list separate from the testing record.
 - p. Provide the CM and owner with written progress reports noting substantive issues with recommended actions.
 - q. Provide a final commissioning report as described in part 1 Commissioning Record.
- F. Construction Manager (CM):
- 1. Construction and Acceptance Phase:
 - a. Include the cost of commissioning (CM's and Sub's content) in the total contract price.
 - b. Furnish in a timely manner a copy of all construction documents, addenda, change orders and accepted submittals and shop drawings related to commissioned systems and equipment to the CxA.
 - c. Verify that all Subs execute their commissioning responsibilities according to the contract documents and schedule.
 - d. Facilitate the coordination of the commissioning work by the CxA, and, with the CxA, verify that commissioning activities are being scheduled into the master schedule.
 - e. Attend a commissioning kick-off meeting and other commissioning team meetings.
 - f. Perform the normal review of contractor submittals.
 - g. Review the functional performance test procedures submitted by the CxA, prior to testing.

- h. Observe and witness pre-functional checkout, startup and functional testing of selected equipment.
 - i. Review commissioning progress and Cx issues tracking list.
 - j. Coordinate the resolution of non-compliance and design deficiencies identified in all phases of commissioning.
 - k. Coordinate the training of owner personnel.
 - l. Prepare O&M manuals, according to the contract documents, including clarifying and updating the original sequences of operation to as-built conditions.
 - 2. Warranty Period:
 - a. Assist the CxA as necessary in the seasonal or deferred testing and deficiency corrections required by the specifications.
 - b. Verify that subs execute seasonal or deferred functional performance testing, witnessed by the CxA, according to the specifications.
 - c. Verify that Subs correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.
- G. Owner's Project Manager (PM):
 - 1. Construction and Acceptance Phase:
 - a. Manage and enforce the contract of the A/E, CM, and CxA.
 - b. Arrange for facility operating and maintenance personnel to attend various field commissioning activities and field training sessions.
 - c. Review occupancy complaints and determine corrective action to be provided by owner or appropriate subcontractor.
 - 2. Warranty Period:
 - a. Verify that any seasonal or deferred testing and any deficiency issues are addressed.
 - b. Review occupancy complaints and determine corrective action to be provided by owner or appropriate subcontractor.
- H. Trade Contractors (Divisions 21, 22, 23, 26, and 28):
 - 1. Construction and Acceptance Phase:
 - a. Include cost for work associated with commissioning in contract price.
 - b. Attend commissioning kick-off meeting and other meetings necessary to facilitate commissioning process.
 - c. Provide CxA, thru CM, with normal cut sheets and shop drawing submittals of commissioned equipment.
 - d. Provide CxA, thru CM, with detailed testing plan, procedures and checklists for each series of tests.
 - e. Certificate of Readiness: Provide CxA, thru CM, with a certificate of readiness from each trade Contractor certifying that systems, subsystems, equipment and associated controls are ready for testing.
 - f. Certificate of Completion of Installation Pretest and Start-up: Certify that installation, pretest and start-up activities have been completed in accordance with approved shop drawings, manufacturers recommendation, AHJ requirements and requirements of the Project Specifications.
 - g. Certified Pipe Cleaning, Flushing and Testing Report: Certify that pipe cleaning, flushing, hydrostatic testing, and pneumatic testing have been completed in accordance with AHJ requirements and Project Specifications. Provide copies of signed flushing and testing certificates.
 - h. Provide additional requested documentation to CxA for development of start-up and functional testing procedures. This data will be requested prior to the initial submittal and will become part of the submittal package.
 - i. Assist in clarifying operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.

- j. Provide assistance to the CxA in preparing the specific functional testing procedures. Review test procedures to verify feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests.
 - k. Develop full start-up and initial checkout plan using manufacturer's start-up procedures and pre-functional checklists from CxA for commissioned equipment. Submit to CxA for review and approval prior to startup.
 - l. Perform and document pre-functional checks, startup, and initial checkout for commissioned equipment. Provide a copy of all checklists and startup forms to the CxA.
 - m. Address punch list items before functional testing.
 - n. Verify that air and water TAB is complete with discrepancies and problems remedied before performing functional testing of respective systems. TAB contractors should provide support to the CxA to verify, the TAB readings.
 - o. Provide skilled technicians to assist the CxA during the functional performance testing procedure. Verify that they are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustments and problem solving. The primary subcontractor for this task is the controls contractor with involvement from the mechanical and electrical sub-contractors.
 - p. Correct issues and deficiencies and retest equipment.
 - q. Prepare O&M manuals in accordance with Divisions 22, 23 and 26, including clarifying and updating original sequences of operation to as-built conditions.
 - r. During construction, maintain as-built drawings. Update and submit after completion of commissioning.
 - s. Provide a training plan and training of owner's operating staff using qualified personnel familiar with the project.
 - t. Coordinate with equipment manufacturers to determine specific requirements to maintain warranty.
2. Warranty Period:
- a. Execute seasonal or deferred functional performance testing, witnessed by CxA in accordance with the specifications.
 - b. Correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.

PART 3 EXECUTION

2.01 PREPARATION

- A. Certify that systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.
- B. Certify that instrument and control system have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.
- C. Certify that testing, adjusting, and balancing procedures have been completed and that testing, adjusting, and balancing reports have been submitted, discrepancies corrected, and corrective work approved.
- D. Set systems, subsystems, and equipment into operating mode to be tested (e.g. normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
- E. Inspect and verify the position of each device and interlock identified on checklists.
- F. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.
- G. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

2.02 TESTING AND BALANCING VERIFICATION

- A. Prior to performance of testing and balancing Work, provide copies of reports, sample forms, checklists, and certificates to the CxA.
- B. Notify the CxA at least 10 days in advance of testing and balancing work, and provide access for the CxA to witness testing and balancing work.
- C. Provide technicians, instrumentation, and tools to verify testing and balancing of the mechanical, plumbing, fire protection etc at the direction of the CxA.
 - 1. The CxA will notify testing and balancing Contractor 10 days in advance of the date of field verification. Notice will not include data points to be verified.
 - 2. The testing and balancing contractor shall use the same instruments (by model and serial number) that were used when original data were collected.
 - 3. Failure of an item includes, other than sound, a deviation of more than 10 percent. Failure of more than 10 percent of selected items shall result in rejection of final testing, adjusting, and balancing report. For sound pressure readings, a deviation of 3 dB shall result in rejection of final testing. Variations in background noise must be considered.
 - 4. Remedy the deficiency and notify the CxA so verification of failed portions can be performed.

2.03 MEETINGS

- A. Commissioning Kick-Off Meeting: Within 30 days of commencement of construction, the CxA will schedule, plan and conduct a commissioning coordination meeting with the entire commissioning team in attendance. Meeting minutes and updated test plans will be distributed to all parties by the CxA.
- B. Routine Commissioning Meetings: Periodic meetings will be planned and conducted by the CxA as construction progresses. These meetings will cover coordination, deficiency resolution and planning issues with particular Subs. The CxA will plan these meetings to minimize time spent by Subs. These meetings will be held monthly and will increase in frequency as the project draws closer to completion. Meeting minutes and updated test plans will be distributed to all parties by the CxA.

2.04 REPORTING

- A. The CxA will provide regular reports to the owner, A/E, and CM, with increasing frequency as construction and commissioning progresses.
- B. The CxA will regularly communicate with all members of the commissioning team, keeping them apprised of commissioning progress, issues and deficiencies, and scheduling changes through memos, progress reports, etc.
- C. The CxA will provide a Final Commissioning Report to the owner and CM as described in Part 1, Commissioning Record.

2.05 PREFUNCTIONAL CHECKLISTS AND START-UP

- A. The following procedures apply to all systems and equipment to be commissioned.
- B. General: Pre-functional checklists (PFC's) are important to verify that the equipment and systems are connected properly and are operational. PFC's verify that functional testing may proceed without unnecessary delays. The contractor shall be responsible for performing pre-functional checks. EVERY piece of equipment, as outlined in Part 1, "Systems To Be Commissioned" receives a full pre-functional checkout.
- C. The primary role of the CxA in this process is to verify that there is written documentation and that each of the manufacturer-recommended procedures has been completed.
 - 1. The CxA prepares pre-functional checklists for the selected systems. These checklists are provided to the CM for distribution to the responsible trade(s). Each form will have more than one trade responsible for its execution.
 - 2. The CM is responsible that ALL Subs complete the pre-functional checklist as identified by BIC "body-in-charge" designations.

- D. Execution of Pre-functional Checklists and Startup:
 - 1. Subs and vendors schedule startup and checkout with the CM and CxA.
 - 2. The Subs and vendors shall execute startup and provide the CxA with a signed and dated copy of the completed start-up and pre-functional checklists. Only individuals that have direct knowledge and have witnessed that a line item task on the pre-functional checklist was actually performed shall initial or check off that item.
 - 3. The CxA may observe selected pre-functional tests and startup procedures.
 - 4. The CxA will review ALL pre-functional checklists furnished by Subs and vendors and compile in the commissioning record.
- E. Issues and Deficiency Resolution:
 - 1. The Subs shall clearly list any issues and deficiencies identified in the initial start-up and PFC procedures and return the completed test form to the CxA within two days.
 - 2. Problem Solving: The CxA may recommend solutions to problems found, however the burden of responsibility to solve, correct and retest problems is with the CM, Subs and A/E.
 - 3. The installing Subs or vendors shall correct all areas that are deficient in a timely manner and notify the CxA as soon as outstanding items have been corrected. An updated PFC form shall be submitted to CxA when complete.
 - 4. Upon completion of all associated PFC's, the system will then be scheduled for functional testing by the commissioning team.

2.06 FUNCTIONAL TESTING

- A. This article applies to all commissioning functional testing for all divisions.
- B. A detailed list of systems to be commissioned is referenced in Article 1.11, "Systems To Be Commissioned."
- C. The CxA will identify Subs responsible to execute and/or assist in functional testing.
- D. Objectives and Scope: The objective of functional testing is to demonstrate that each system is operating according to the design intent and contract documents.
- E. In general, each system will be tested in all modes of operation (seasonal, occupied, unoccupied, warm-up, cool-down, part- and full-load, etc.).
- F. Development of Test Procedures:
 - 1. Subs and their vendors provide CM and CxA with documents describing final approved equipment, configuration and control sequences.
 - 2. The CxA develops specific test procedures and forms to verify and document proper operation of each system.
 - 3. Prior to execution, the CxA shall provide a copy of the test procedures to the Sub(s) who shall review the tests for feasibility, safety, equipment and warranty protection.
 - 4. The CM will provide the CxA with copies of owner-contracted, factory testing or acceptance tests that the CxA is not responsible to oversee. The CxA shall include these tests in the commissioning record.
- G. Forms:
 - 1. The test procedure forms developed by the CxA shall include (but not be limited to) the following information:
 - a. System and equipment or component name(s)
 - b. Equipment location and ID number
 - c. Pre-functional checklist and start-up documentation ID numbers for the piece of equipment
 - d. Date
 - e. Project name
 - f. Participating parties
 - g. A copy of the specification section describing the test requirements

- h. A copy of the specific sequence of operations or other specified parameters being verified
 - i. Formulas used in any calculations
 - j. Required pre-test field measurements
 - k. Instructions for setting up the test
 - l. Special cautions, alarm limits, etc.
 - m. Specific step-by-step procedures to execute the test, in a clear, sequential and repeatable form.
 - n. Acceptance criteria of proper performance with a Yes / No check box to allow for clearly marking whether or not proper performance of each part of the test was achieved
 - o. A section for comments
 - p. Signatures and date block for the CxA
- H. Test Methods:
 - 1. Functional performance testing will generally be achieved by manipulating the control systems or equipment and observing system response. Means by which manipulation may occur include:
 - a. Simulated conditions
 - b. Overwritten values
 - c. Simulated signals
 - d. Altering set points
 - 2. Setup: Each test shall be performed under conditions that simulate actual conditions as close as practically possible.
 - 3. Trend logging or data loggers may be used to confirm short or long term system response and performance.
 - 4. At completion of a test, the Sub shall return all affected building equipment and systems to their pre-test conditions.
 - 5. Sampling: Multiple identical pieces of non-life-safety or non-critical equipment may be functionally tested using a sampling strategy. Systems to be tested by sampling methods, if any, are identified in Section 1.11 "Systems To Be Commissioned." If sampling strategy is applied, the CxA shall define systems appropriate for sampling and specify sampling population. Note: No sampling will be allowed in pre-functional checklist execution.
 - a. The following strategy ("xx% Sampling—yy% Failure Rule") shall be utilized when functional performance testing is applied to a sample of the project systems:
 - 1) xx = the percent of the group of identical equipment to be included in each sample.
 - 2) yy = the percent of the sample that if failing, will require another sample to be tested.
 - b. The example below describes a 20% Sampling—10% Failure Rule.
 - 1) Randomly test at least 20 percent (xx) of each group of identical equipment. In no case test less than three units in each group. This 20 percent, or three, constitute the "first sample."
 - 2) If 10 percent (yy) of the units in the first sample fail the functional performance tests, test another 20 percent of the group (the second sample).
 - 3) If 10 percent of the units in the second sample fail, test all remaining units in the whole group.
 - 4) If at any point, frequent failures are occurring and testing is becoming more troubleshooting than verification, the CxA may stop the testing and require the responsible Sub to perform and document a checkout of the remaining units, prior to continuing with functionally testing the remaining units.
- I. Coordination and Scheduling:

1. The Subs shall provide sufficient notice to the CxA regarding their completion schedule for the pre-functional checklists and startup of all equipment and systems. The CxA will schedule functional tests through the CM and related Subs. The CxA shall direct, witness and document the functional testing of all equipment and systems. The Subs shall execute the tests.
 2. Functional testing is conducted after pre-functional testing and startup has been satisfactorily completed. The control system is sufficiently tested and approved by the CxA before it is used for functional testing or to verify performance of other components or systems. The air balancing and water balancing is completed and debugged before functional testing of air-related or water-related equipment or systems. Testing proceeds from components to subsystems to systems. When the proper performance of all interacting individual systems has been achieved, the interface or coordinated responses between systems is checked.
- J. Test Equipment: Refer to Article 2.1, "TEST EQUIPMENT" for test equipment requirements.
- K. Issues and Deficiency Resolution: (See Article 3.5, "ISSUES, DEFICIENCIES AND COST OF RETESTING")

2.07 ISSUES, DEFICIENCIES AND COST OF RETESTING

- A. Issues and Deficiencies:
1. All issues and deficiencies shall be noted in the Cx Issues Tracking List by the CxA.
 2. The CxA shall work with the CM and Subs to correct issues or deficiencies identified during functional testing. The CxA will involve the PM, and request the A/E and others, as necessary. The CxA may recommend solutions to problems found, however the burden of responsibility to solve, correct and retest problems is with the CM, Subs and A/E. The PM should assist in the resolution of issues.
 3. Corrections of minor deficiencies identified may be made during the tests at the discretion of the CxA. In such cases the deficiency and resolution will be documented on the procedure form.
 4. Every effort will be made to expedite the testing process and minimize unnecessary delays, while not compromising the integrity of the procedures. However, the CxA will not be pressured into overlooking deficient work or loosening acceptance criteria to satisfy scheduling or cost issues, unless there is an overriding reason to do so at the request of the CM and PM.
 5. As tests progress and a deficiency is identified, the CxA discusses the issue with the executing contractor.
 - a. When there is no dispute on the deficiency and the Sub accepts responsibility to correct it and notifies the CxA of completion.
 - 1) The CxA reschedules the test and the test is repeated.
 - b. If there is a dispute about a deficiency, regarding whether it is a deficiency or who is responsible:
 - 1) Once the interpretation and resolution have been decided, in cooperation with the CM, the appropriate party corrects the deficiency and notifies the CxA of completion.
 - 2) The CxA reschedules the test and the test is repeated.
 6. The CxA retains the original Cx Issues Tracking List until the end of the project.
- B. Cost of Retesting:
1. The cost for the Sub to retest a pre-functional or functional test, if they are responsible for the deficiency, shall be theirs. If they are not responsible, all cost recovery for retesting shall be negotiated with the CM.
 2. For a deficiency related to functional testing, the following shall apply: The CxA and CM to direct any retesting on systems or equipment reported to have been successfully completed, but determined during functional testing to be faulty, will be back charged by the CM to the Sub responsible for necessitating the retesting.

3. Refer to the sampling paragraph of this article for requirements for testing and retesting identical equipment.
4. Any required retesting shall not be considered a justified reason for a claim of delay or for a time extension by any contractor.

2.08 WRITTEN WORK PRODUCTS

- A. The commissioning process generates a number of written work products described in various parts of the Project Manual. The commissioning plan lists all the formal written work products, describes briefly their contents, who is responsible to create them, their due dates, who receives and approves them and the location of the specification to create them. In summary, the written products are:

	Product	Developed By
1.	Commissioning Plan	CxA
2.	Cx Kick-off Meeting & Minutes	CxA
3.	Commissioning Schedules	CxA with CM
4.	Equipment Submittals	Subs
5.	Sequence Clarifications	Subs and A/E as needed
6.	Pre-functional Checklist Forms	CxA with assistance of Subs
7.	Pre-functional Checklist and Contractor/Vendor Startup Forms (filled out)	Subs
8.	Final TAB Reports	TAB
9.	Cx Issues Tracking List	CxA
10.	Commissioning Field Trip Reports	CxA
11.	Functional Test Forms	CxA
12.	Functional Test Forms (filled out)	CxA with assistance of Subs

END OF SECTION

**SECTION 21 24 00
DRY-CHEMICAL FIRE-EXTINGUISHING SYSTEM**

PART 2 PRODUCTS

1.01 DRY-CHEMICAL FIRE SUPPRESSION SYSTEM REQUIREMENTS

- A. Provide a pre-engineered modular type, fixed pipe, automatic dry chemical fire suppression system for the hazard including associated ductwork, exhaust ventilation pits, plenums, and work area(s) requiring protection.
- B. System to consist of manufacturer's dry chemical storage cylinders, actuation hardware, and distribution nozzles attached to the pipe network.
- C. System to comply with NFPA 17, NFPA 33, and NFPA 34 including extinguishing agent.

1.02 FIRE-SUPPRESSION SYSTEM CONTROLLER

- A. Engineered system capable of automatic and manual discharge of dry-chemical agent from cylinder(s) using actuated valve(s), heat fuel source shutdown, smoke or fire-smoke damper closure, and electrical power shutdown to equipment or protected area upon system activation by thermal fusible link or heat detector.
- B. Provide system controller in the form of fire alarm system monitored, self-contained control panel or module.
- C. Furnish fully enclosed, integral control head and actuator for each container cylinder valve assembly without exposed means for actuation.
 - 1. Control Head: Equip with micro-switch contacts for audible alarm and equipment shutdown.
- D. The container cylinders protecting one hazard area must be connected for simultaneous discharge by each method of alarm actuation.
- E. Activate control head automatically by mechanical means.
 - 1. Provide listed, rate-compensated thermostat fire detectors complying with NFPA 17, with rating suitable to their expected exposure temperature, capable of detecting and indicating heat, flame, smoke, combustible vapors, or an abnormal condition in the hazard that is likely to produce a fire.
 - 2. Mechanical Activation:
 - a. Activate system control head by manufacturer supplied fire detectors incorporating mechanical thermo-bulb link systems requiring no outside power source for operation.
 - b. Provide thermo-bulb links with rating suitable to their expected exposure temperature.
- F. Initiating Devices:
 - 1. Manual Pull Station:
 - a. Provide as means of manually actuating the system from remote location.
 - b. Surface housing fitted with un-tensioned pull-to-trip that locks in position after allowing the control system to activate the cylinder and valve assembly, for mounting on electrical outlet box; addressable using manufacturer's standard monitor module.
 - c. Functions:
 - 1) Activate audible and visual alarms.
 - 2) Override any abort station or time delay function.
 - 3) Activate release and shutdown functions normally triggered by detectors or alarm system.
 - d. Identification:
 - 1) Provide engraved label for each manual release station indicating area protected and that actuation will cause discharge of fire extinguishing agent.
 - 2) Provide manufacturer's label directly on faceplate.

2. Manual System Abort Switch:
 - a. Stainless steel plate with momentary contact push button, countdown timer, magnetic door holders manual release, for mounting on electrical outlet box; addressable using manufacturer's standard monitor module.
 - b. Engraved Sign or Label: Provide adjacent to each manual abort station, indicating area protected and that actuation will prevent discharge of fire extinguishing agent after automatic system is activated.
- G. Notification and Control Devices:
 1. Alarm Bells: 24 VDC with supervision of circuit wiring, of modular design, red baked enamel finish, with minimum sound level of 84 dba at 10 feet (3 m), for mounting on 4 inch (100 mm) electrical outlet box.
 2. Alarm Horns: 24 VDC with supervision of circuit wiring, with minimum sound level of 90 dba at 10 feet (3 meters), for mounting on 4 inch (100 mm) electrical outlet box.
 3. Strobe Beacon: 24 VDC with system identification on strobe lens.

1.03 SPACE OR AREA SIGNAGE

- A. Entrance Warning Sign: One warning sign at each entrance to protected area.
- B. Exit Warning Signs: One lighted, flashing warning sign at each exit from protected area.

1.04 SYSTEM PIPING AND SPECIALTIES

- A. Steel Pipe: ASTM A53/A53M or ASTM A106/A106M Schedule 40, or ASTM A135/A135M Schedule 10, hot dipped galvanized.
 1. Fittings: ASME B16.3 malleable iron class 300 for sizes 2 inch (50 mm) and smaller, or ASTM A234/A234M, wrought steel welding type fittings.
 2. Joints: Threaded, AWS D1.1/D1.1M welded, or grooved and shouldered pipe end couplings.
- B. Pipe Hangers: ASME B31.1, listed, split clamp up to 2-1/2 inch (60 mm) size, riser clamps over 2-1/2 inch (60 mm) size, adequate to offset discharge thrust.
- C. Escutcheons: Chrome plated pressed or stamped brass, one-piece or split pattern, minimum 2 inches (50 mm) larger than opening.
- D. Gauges: ASME B40.100, UL 393, or UL 404 ; cast 3-1/2 inch (9- mm) diameter cast aluminum case, phosphor bronze bourdon tube, rotary brass movement, brass socket, front recalibration adjustment, black figures on white background, one percent mid-scale accuracy, scale calibrated in both psi and kPa.

1.05 DRY-CHEMICAL AGENT CONTAINERS

- A. Provide steel cylinder and valve assemblies of the type and size required by the manufacturer for dry chemical storage.
- B. Specialties to consist of valves and pressure gauges, including reliable and safe means of minimizing accidental discharge.
- C. Furnish pressurized assembly with the capability of being stored and operated at the following temperature ranges:
- D. Provide listed bracketing for the mounting of the cylinder securely to the intended mounting surface.
- E. Furnish manufacturer's high-pressure nitrogen tubing when the control system is mounted to a dry cylinder and in cases where actuation delay is employed.

1.06 AGENT DISCHARGE NOZZLES

- A. Flow Restrictors: Designed and supplied by the extinguishing system manufacturer to restrict flow of dry chemical through the in-line distribution piping to ensure the appropriate quantity of agent is delivered to each nozzle in the distribution system.

- B. Identification: Permanently marked with manufacturer's identification system identifying nozzle type and listing.

END OF SECTION

SECTION 22 05 23
GENERAL DUTY VALVES FOR PLUMBING PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. General Requirements for Valves
 - 1. Valve Actuator Types
 - 2. Valves in Insulated Piping
 - 3. Valve-End Connections
- B. Bronze Ball Valves, Lead Free
 - 1. Bronze, Two Piece (B-1)
 - 2. Bronze, Three Piece (B-2)
- C. Brass Ball Valves, Lead Free
 - 1. Dezincification Resistant Brass, Two Piece (B-3)
 - 2. Dezincification Resistant Brass, Three Piece (B-4)
- D. Stainless Steel Ball Valves (SSB-1)
- E. Iron, single-flange butterfly valves.
 - 1. 200 CWP (BF-1)
- F. Iron, grooved-end butterfly valves.
 - 1. 300 CWP (BF-1a)
- G. Stainless steel, grooved-end butterfly valves (SSBF-1)
- H. Bronze swing check valves.
 - 1. Bronze, Class 125 (CH-1)
 - 2. Bronze, Class 150 (CH-3)
- I. Iron swing check valves.
 - 1. Iron, Class 125 (CH-2)
 - 2. Iron, Class 250 (CH-4)
- J. Bronze gate valves.
 - 1. Bronze, Class 125 (G-1)
 - 2. Bronze, Class 150 (G-2)
 - 3. Gate Valves, Lead Free, Flanged Ends - Iron, NRS, Class 125 (G-3)
 - 4. Class 125, OS&Y, Iron Gate Valves (G-4)
 - 5. Gate Valves, Lead Free, Flanged Ends - Iron, NRS, Class 250 (G-5)
 - 6. Class 250, OS&Y, Iron Gate Valves (G-6)
- K. Bronze globe valves (GL-1, GL-3).
 - 1. Bronze, Class 125
 - 2. Bronze, Class 150
- L. Iron globe valves (GL-2, GL-4).
 - 1. Iron, Class 125
 - 2. Iron, Class 250
- M. Chainwheels.

1.02 GENERAL REFERENCES

- A. Contract Documents: Refer to complete set of Contract Documents for requirements that are related to or may affect the work described in this Section.
- B. Division 20, including all Common Mechanical Requirements in Section 20 00 00, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.

- C. Division 22 plumbing piping Sections for specialty valves applicable to those Sections only.
- D. Section 20 05 53 - Mechanical Identification for valve tags and schedules.
- E. Division 33 water distribution piping Sections for general-duty and specialty valves for site construction piping.

1.03 REFERENCE STANDARDS

- A. ASME B1.20.1 - Pipe Threads, General Purpose, Inch; 2013 (Reaffirmed 2018).
- B. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250; 2020.
- C. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24 Metric/Inch Standard; 2025.
- D. ASME B16.10 - Face-to-Face and End-to-End Dimensions of Valves; 2022, with Errata (2023).
- E. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings (ANSI B16.18); 2021.
- F. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2021.
- G. ASME B16.34 - Valves — Flanged, Threaded, and Welding End; 2025.
- H. ASME B31.9 - Building Services Piping; 2020.
- I. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings; 2004 (Reapproved 2023).
- J. ASTM A536 - Standard Specification for Ductile Iron Castings; 1984, with Editorial Revision (2019).
- K. ASTM A743/A743M - Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application; 2021.
- L. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings; 2017.
- M. AWWA C606 - Grooved and Shouldered Joints; 2022.
- N. MSS SP-45 - Drain and Bypass Connections; 2020.
- O. MSS SP-67 - Butterfly Valves; 2022.
- P. MSS SP-70 - Gray Iron Gate Valves, Flanged and Threaded Ends; 2011.
- Q. MSS SP-71 - Gray Iron Swing Check Valves, Flanged and Threaded Ends; 2018.
- R. MSS SP-80 - Bronze Gate, Globe, Angle, and Check Valves; 2019.
- S. MSS SP-85 - Gray Iron Globe and Angle Valves, Flanged and Threaded Ends; 2011.
- T. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; Approved Edition.
- U. NSF 61 - Drinking Water System Components - Health Effects; Approved Edition.
- V. NSF 372 - Drinking Water System Components - Lead Content; 2024.

1.04 ABBREVIATIONS AND ACRONYMS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene copolymer rubber.
- C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
- D. NRS: Nonrising stem.
- E. OS&Y: Outside screw and yoke.
- F. RPTFE: Reinforced polytetrafluoroethylene
- G. RS: Rising stem.
- H. SWP: Steam working pressure.

- I. WOG: Water, oil, gas.

1.05 PERFORMANCE REQUIREMENTS

- A. Domestic water valves intended to convey or dispense water for human consumption must comply with the SDWA, requirements of authorities having jurisdiction, and NSF 61 and NSF 372, or must be certified to be in compliance with NSF 61 and NSF 372 (by an ANSI-accredited third-party certification body) that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.
- B. ASME Compliance:
1. ASME B1.20.1 for threads for threaded end valves.
 2. ASME B16.1 for flanges on iron valves.
 3. ASME B16.5 for flanges on steel valves.
 4. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
 5. ASME B16.18 for cast copper solder-joint connections.
 6. ASME B16.22 for wrought copper and copper alloy solder-joint connections.
 7. ASME B16.34 for flanged and threaded end connections
 8. ASME B31.9 for building services piping valves
 9. Product Data: For each type of product indicated.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Prepare valves for shipping as follows:
1. Protect internal parts against rust and corrosion.
 2. Protect threads, flange faces, grooves, and weld ends.
 3. Set angle, gate, and globe valves closed to prevent rattling.
 4. Set ball and plug valves open to minimize exposure of functional surfaces.
 5. Set butterfly valves closed or slightly open.
 6. Block check valves in either closed or open position.
- B. Use the following precautions during storage:
1. Maintain valve end protection.
 2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.
- D. Source Limitations
1. Obtain each type of valve from single source from single manufacturer.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS FOR VALVES

- A. Refer to valve schedule articles for applications of valves.
- B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- C. Valve Sizes: Same as upstream piping unless otherwise indicated.
- D. Valve Actuator Types:
1. Gear Actuator: For quarter-turn valves NPS 4 (DN 100) and larger.
 2. Handwheel: For valves other than quarter-turn types.
 3. Handlever: For quarter-turn valves NPS 4 (DN 100) and smaller except plug valves.
 4. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.
- E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:
1. Gate Valves: With rising stem.

2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
 3. Butterfly Valves: With extended neck.
 4. Memory stops that are fully adjustable after insulation is applied.
- F. Valve-End Connections:
1. Flanged: With flanges according to ASME B16.1 for iron valves, ASME B16.5 for steel valves.
 2. Grooved: With grooves according to AWWA C606.
 3. Solder Joint: With sockets according to ASME B16.18.
 4. Threaded: With threads according to ASME B1.20.1.
 5. Valve Bypass and Drain Connections: MSS SP-45.

2.02 BRONZE BALL VALVES, LEAD FREE

- A. Two-Piece, Full-Port, Bronze Ball Valves with Stainless Steel Trim (B-1):
- a. Conbraco Industries, Inc.; Apollo Valves: 77CLF-100-01A Series (77CLF-200-01A Series)
 - b. Hammond Valve: 8901 (8503)
 - c. Milwaukee Valve Company: UPBA-400 (UPBA-450)
 - d. NIBCO INC: T-585(-66)-LF
 - e. Jomar.
2. Description:
- a. Standard: MSS SP-110.
 - b. SWP Rating: 150 psig (1035 kPa).
 - c. CWP Rating: 600 psig (4140 kPa).
 - d. Body Design: Two piece.
 - e. Body Material: Bronze.
 - f. Ends: Threaded (Soldered).
 - g. Seats: PTFE, TFE
 - h. Stem: Stainless Steel
 - i. Ball: Stainless Steel
 - j. Port: Full.
- B. Three-Piece, Full-Port, Bronze or Forged Brass Ball Valves with Stainless Steel Trim (B-2):
- a. Conbraco Industries, Inc.; Apollo Valves: 82LF-200 Series
 - b. Hammond Valve: 8604
 - c. Milwaukee Valve Company: UPBA-300 Series
 - d. NIBCO INC: T-590-Y-LF
 - e. Jomar.
2. Description:
- a. Standard: MSS SP-110.
 - b. SWP Rating: 150 psig (1035 kPa).
 - c. CWP Rating: 600 psig (4140 kPa).
 - d. Body Design: Three piece.
 - e. Body Material: Bronze or Forged Brass.
 - f. Ends: Threaded or soldered.
 - g. Seats: PTFE, TFE or Hostafion.
 - h. Stem: Stainless Steel.
 - i. Ball: Stainless Steel.
 - j. Port: Full.

2.03 BRASS BALL VALVES, LEAD FREE

- A. As an alternate, and only if submitted with proper alternate bid procedures as defined in Division 01 Specification Sections, may the contractor submit on Dezincification Resistant Brass ball valves. Project shall be priced with Bronze as specified above as the base, and Dezincification Resistant Brass as an alternate deduct.
- B. Ball Valves, Lead Free, Threaded or Soldered Ends – Dezincification Resistant Brass, Two Piece with Full Port and Stainless-Steel Trim (B-3):
 - a. Conbraco Industries, Inc.; Apollo Valves
 - b. Hammond Valve
 - c. Milwaukee Valve Company
 - d. NIBCO INC
 - e. Jomar Valve
 - 2. Standards: MSS SP-110 and MSS SP-145.
 - 3. CWP Rating: 600 psig (4140 kPa).
 - 4. Body Design: Two piece.
 - 5. Body Material: Forged brass.
 - 6. Ends: Threaded or soldered. See Part 3 ball valve schedule articles.
 - 7. Seats: PTFE.
 - 8. Stem: Stainless steel.
 - 9. Ball: Stainless steel, vented.
 - 10. Port: Full
- C. Ball Valves, Lead Free, Threaded or Soldered Ends - Dezincification Resistant Brass, Three Piece with Full Port and Stainless-Steel Trim (B-4):
 - a. Conbraco Industries, Inc.; Apollo Valves
 - b. Hammond Valve
 - c. Milwaukee Valve Company
 - d. NIBCO INC
 - e. Jomar Valve
 - 2. Standards: MSS SP-110 and MSS SP-145.
 - 3. CWP Rating: 600 psig (4140 kPa).
 - 4. Body Design: Three piece.
 - 5. Body Material: Forged brass.
 - 6. Ends: Threaded or soldered. See Part 3 ball valve schedule articles.
 - 7. Seats: PTFE.
 - 8. Stem: Stainless steel.
 - 9. Ball: Stainless steel, vented.
 - 10. Port: Full.

2.04 STAINLESS STEEL BALL VALVES

- A. Stainless Steel Ball Valves, Two Piece with Full Port, Threaded or Flanged Ends:
 - a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 - b. Jomar Valve FL-SS-100-150
 - 2. Standard: MSS SP-110; MSS SP-145.
 - 3. CWP Rating: 200 psig (1380 kPa).
 - 4. Body Design: Split body.
 - 5. Body Material: Type 316 stainless steel.
 - 6. Ends: Threaded or flanged.
 - 7. Ends: Threaded or flanged.
 - 8. Seats: PTFE.
 - 9. Stem: Type 316 stainless steel.
 - 10. Ball: Type 316 stainless steel.
 - 11. Port: Full

2.05 IRON, SINGLE-FLANGE BUTTERFLY VALVES

- A. 200 CWP, Iron, Single-Flange Butterfly Valves with NBR Seat and Aluminum-Bronze or Stainless Steel Disc (BF-1):
 - a. Conbraco Industries, Inc.; Apollo Valves: LD/WD 141
 - b. Hammond Valve: 6411/6311
 - c. Milwaukee Valve Company: CL Series.
 - d. NIBCO INC.: LD/WD-2000
 - e. Jomar Valve: BFV-Lug
- 2. Description:
 - a. Standard: MSS SP-67, Type I.
 - b. CWP Rating: 200 psig (1380 kPa).
 - c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - d. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
 - e. Seat: NBR.
 - f. Stem: One- or two-piece stainless steel.
 - g. Disc: Aluminum bronze or stainless steel.

2.06 IRON, GROOVED-END BUTTERFLY VALVES

- A. 300 CWP, Iron, Grooved-End Butterfly Valves (BF-1a):
 - a. Victaulic Company: Series 706
 - b. Shurejoint Series 300
- 2. Description:
 - a. Standard: MSS SP-67, Type I.
 - b. NPS 8 (DN 200) and Smaller CWP Rating: 300 psig (2070 kPa).
 - c. NPS 10 (DN 250) and Larger CWP Rating: 200 psig (1380 kPa).
 - d. Body Material: Coated, ductile iron.
 - e. Stem: Two-piece stainless steel.
 - f. Disc: Coated, ductile iron.
 - g. Seal: EPDM.

2.07 STAINLESS STEEL, GROOVED-END BUTTERFLY VALVES

- 1. Victaulic Company
- 2. Shurejoint
- B. Standard: MSS SP-67, Type I.
- C. CWP Rating, NPS 8 (DN 200) and Smaller: 300 psig (2070 kPa).
- D. CWP Rating, NPS 10 (DN 250) and Larger: 200 psig (1380 kPa).
- E. Body Material: Type 316 stainless steel, ASTM A743/A743M.
- F. Stem: Type 416 stainless steel.
- G. Disc: Type 316 stainless steel or ductile iron, encapsulated with Grade "EN" EPDM.
- H. Seal: EDPM

2.08 BRONZE SWING CHECK VALVES

- A. Class 125, Bronze Swing Check Valves with Bronze Disc (CH-1):
 - a. Milwaukee Valve Company: UP509
 - b. NIBCO INC.: T-413-LF
 - c. Conbraco Industries, Apollo Valves: 163T-LF
- 2. Description:
 - a. Standard: MSS SP-80, Type 3.
 - b. CWP Rating: 200 psig (1380 kPa).

- c. Body Design: Horizontal flow.
 - d. Body Material: ASTM B62, bronze.
 - e. Ends: Threaded.
 - f. Disc: Bronze.
- B. Class 150, Bronze Swing Check Valves with Bronze Disc (CH-3):
- a. Milwaukee Valve Company: UP548T
 - b. NIBCO INC.: T-433-LF
 - c. Conbraco Industries, Apollo Valves: 164T-LF
 - d. Jomar Valve T/S-511G
2. Description:
- a. Standard: MSS SP-80, Type 3.
 - b. CWP Rating: 300 psig (2070 kPa).
 - c. Body Design: Horizontal flow.
 - d. Body Material: ASTM B62, bronze.
 - e. Ends: Threaded.
 - f. Disc: Bronze.

2.09 IRON SWING CHECK VALVES

- A. Class 125, Iron Swing Check Valves with Metal Seats (CH-2):
- a. Hammond Valve: IR 1124
 - b. Milwaukee Valve Company: 2974-FP
 - c. NIBCO INC.: 918-LF
 - d. Conbraco Industries, Apollo Valves: 910F-LF
 - e. Jomar Valve: F-571
2. Description:
- a. Standard: MSS SP-71 , Type I.
 - b. CWP Rating: 200 psig (1380 kPa).
 - c. Body Design: Clear or full waterway.
 - d. Body Material: ASTM A126, gray iron with bolted bonnet.
 - e. Ends: Flanged.
 - f. Trim: Bronze.
 - g. Gasket: Asbestos free.
- B. Class 250, Iron Swing Check Valves with Metal Seats (CH-4):
- a. Hammond Valve: IR 322
 - b. Milwaukee Valve Company: 2970A
 - c. NIBCO INC.: 968-B
 - d. Conbraco Industries, Apollo Valves: 920F-LF
2. Description:
- a. Standard: MSS SP-71, Type I.
 - b. CWP Rating: 500 psig (3450 kPa).
 - c. Body Design: Clear or full waterway.
 - d. Body Material: ASTM A126, gray iron with bolted bonnet.
 - e. Ends: Flanged.
 - f. Trim: Bronze.
 - g. Gasket: Asbestos free.

2.10 BRONZE GATE VALVES

- A. Class 125, RS Bronze Gate Valves (G-1):
- a. Hammond Valve: IB 645
 - b. Milwaukee Valve Company: UP105
 - c. NIBCO INC.: T-124

- d. Conbraco Industries, Apollo Valves: 103T-LF
- e. Jomar Valve: T/S-351G
- 2. Description:
 - a. Standard: MSS SP-80, Type 2.
 - b. CWP Rating: 200 psig (1380 kPa).
 - c. Body Material: ASTM B62, bronze with integral seat and screw-in bonnet.
 - d. Ends: Threaded.
 - e. Stem: Bronze.
 - f. Disc: Solid wedge; bronze.
 - g. Packing: Asbestos free.
 - h. Handwheel: Malleable iron, bronze.
- B. Class 150, RS Bronze Gate Valves (G-2):
 - a. Hammond Valve: IB 629
 - b. Milwaukee Valve Company: UP1509
 - c. NIBCO INC.: T-134
 - d. Conbraco Industries, Apollo Valves: 107T-LF
 - e. Jomar Valve: T/S-351G
- 2. Description:
 - a. Standard: MSS SP-80, Type 2.
 - b. CWP Rating: 300 psig (2070 kPa).
 - c. Body Material: ASTM B62, bronze with integral seat and union-ring bonnet.
 - d. Ends: Threaded.
 - e. Stem: Bronze.
 - f. Disc: Solid wedge; bronze.
 - g. Packing: Asbestos free.
 - h. Handwheel: Malleable iron, bronze.
- C. Gate Valves, Lead Free, Flanged Ends - Iron, NRS, Class 125 (G-3)
 - a. Hammond Valve
 - b. Milwaukee Valve Company
 - c. NIBCO INC.
 - d. Conbraco Industries, Apollo Valves
 - e. Jomar Valve
- 2. Description:
 - a. Standard: MSS SP-70, Type I.
 - b. CWP Rating: 200 psig (1380 kPa).
 - c. Body Material: Gray iron with bolted bonnet.
 - d. Ends: Flanged.
 - e. Trim: Bronze.
 - f. Disc: Solid wedge.
 - g. Packing and Gasket: Asbestos free
- D. Class 125, OS&Y, Iron Gate Valves (G-4):
 - a. Hammond Valve: IR 1140
 - b. Milwaukee Valve Company: F-2885A
 - c. NIBCO INC.: F-617-0
 - d. Conbraco Industries, Apollo Valves: 611F-LF
 - e. Jomar Valve F-361
- 2. Description:
 - a. Standard: MSS SP-70, Type I.
 - b. CWP Rating: 200 psig (1380 kPa).
 - c. Body Material: ASTM A126, gray iron with bolted bonnet.

- d. Ends: Flanged.
- e. Trim: Bronze.
- f. Disc: Solid wedge.
- g. Packing and Gasket: Asbestos free.
- E. Gate Valves, Lead Free, Flanged Ends - Iron, NRS, Class 250 (G-5):
 - a. Hammond Valve
 - b. Milwaukee Valve Company
 - c. NIBCO INC.
 - d. Conbraco Industries, Apollo Valves
- 2. Description:
 - a. Standard: MSS SP-70, Type I.
 - b. CWP Rating: 500 psig (3450 kPa).
 - c. Body Material: ASTM A126, gray iron with bolted bonnet.
 - d. Ends: Flanged.
 - e. Trim: Bronze.
 - f. Disc: Solid wedge.
 - g. Packing and Gasket: Asbestos free
- F. Class 250, OS&Y, Iron Gate Valves (G-6):
 - a. Hammond Valve: IR 330
 - b. Milwaukee Valve Company: F-2894A
 - c. NIBCO INC.: F-667-0
 - d. Conbraco Industries, Apollo Valves: 621F-LF
- 2. Description:
 - a. Standard: MSS SP-70, Type I.
 - b. CWP Rating: 500 psig (3450 kPa).
 - c. Body Material: ASTM A126, gray iron with bolted bonnet.
 - d. Ends: Flanged.
 - e. Trim: Bronze.
 - f. Disc: Solid wedge.
 - g. Packing and Gasket: Asbestos free.

2.11 BRONZE GLOBE VALVES

- A. Class 125, Bronze Globe Valves with Bronze Disc (GL-1):
 - a. Hammond Valve: IB 440
 - b. Milwaukee Valve Company: UP502
 - c. NIBCO INC.: T-211
 - d. Conbraco Industries, Apollo Valves: 121T-LF
- 2. Description:
 - a. Standard: MSS SP-80, Type 1.
 - b. CWP Rating: 200 psig (1380 kPa).
 - c. Body Material: ASTM B62, bronze with integral seat and screw-in bonnet.
 - d. Ends: Threaded.
 - e. Stem and Disc: Bronze.
 - f. Packing: Asbestos free.
 - g. Handwheel: Malleable iron, bronze.
- B. Class 150, Bronze Globe Valves with Nonmetallic Disc (GL-3):
 - a. Hammond Valve: IB 413-T
 - b. Milwaukee Valve Company: UP590T
 - c. NIBCO INC.: T-235
 - d. Conbraco Industries, Apollo Valves: 122T-LF
- 2. Description:

- a. Standard: MSS SP-80, Type 2.
- b. CWP Rating: 300 psig (2070 kPa).
- c. Body Material: ASTM B62, bronze with integral seat and union-ring bonnet.
- d. Ends: Threaded.
- e. Stem: Bronze.
- f. Disc: PTFE or TFE.
- g. Packing: Asbestos free.
- h. Handwheel: Malleable iron, bronze

2.12 IRON GLOBE VALVES

- A. Class 125, Iron Globe Valves (GL-2):
 - a. Hammond Valve: IR 116
 - b. Milwaukee Valve Company: F-2981A
 - c. NIBCO INC.: F-718-B
 - d. Conbraco Industries, Apollo Valves: 711F-LF
- 2. Description:
 - a. Standard: MSS SP-85, Type I.
 - b. CWP Rating: 200 psig (1380 kPa).
 - c. Body Material: ASTM A126, gray iron with bolted bonnet.
 - d. Ends: Flanged.
 - e. Trim: Bronze.
 - f. Packing and Gasket: Asbestos free.
- B. Class 250, Iron Globe Valves (GL-4):
 - a. Hammond Valve: IR 313
 - b. Milwaukee Valve Company: F-2983A
 - c. NIBCO INC.: F-768-B
 - d. Conbraco Industries, Apollo Valves: 721F-LF
- 2. Description:
 - a. Standard: MSS SP-85, Type I.
 - b. CWP Rating: 500 psig (3450 kPa).
 - c. Body Material: ASTM A126, gray iron with bolted bonnet.
 - d. Ends: Flanged.
 - e. Trim: Bronze.
 - f. Packing and Gasket: Asbestos free.

2.13 CHAINWHEELS

- 1. Babbitt Steam Specialty Co.
- 2. Roto Hammer Industries.
- 3. Trumbull Industries.
- B. Description: Valve actuation assembly with sprocket rim, brackets, and chain.
 - 1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
 - 2. Attachment: For connection to butterfly valve stems.
 - 3. Sprocket Rim with Chain Guides: Ductile iron, of type and size required for valve.
 - 4. Chain: Hot-dip, galvanized steel, of size required to fit sprocket rim.

PART 3 EXECUTION

3.01 APPLICATION

- A. Valves shall be installed in the following locations and as shown on Drawings:
 - 1. On the building incoming water service.
 - 2. On the discharge side of every meter.
 - 3. On the top of every down-feed riser.
 - 4. On the entrance to every dwelling unit.

5. On the supply side of gravity and pressurized tanks.
 6. On the supply side of every water heater.
 7. On the supply side to every group of fixtures.
 8. On the supply side to each hose bib or non-freeze wall hydrant.
 9. On the supply side to all equipment.
 10. For healthcare facilities, shut-off valves shall be installed for each patient room.
- B. If valve applications are not indicated, use the following:
1. Shutoff Service: Ball, butterfly, or gate valves per schedule below.
 2. Butterfly Valve Dead-End Service: Single-flange (lug) type.
 3. Throttling Service: globe or ball valves per schedule below.
 4. Pump-Discharge Check Valves:
 - a. NPS 2 (DN 50) and Smaller: Bronze swing check valves with bronze disc.
 - b. NPS 2-1/2 (DN 65) and Larger for Domestic Water: Iron swing check valves with lever and weight or with spring or iron, center-guided, metal-seat check valves.
 - c. NPS 2-1/2 (DN 65) and Larger for Sanitary Waste and Storm Drainage: Iron swing check valves with lever and weight or spring.
- C. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings shall be substituted.

3.02 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

3.03 CONNECTIONS

- A. Piping Connections
 1. Select valves, except wafer types, with the following end connections:
 - a. For Copper Tubing, NPS 2 (DN 50) and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
 - b. For Copper Tubing, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules below.
 - c. For Copper Tubing, NPS 5 (DN 125) and Larger: Flanged ends.
 - d. For Steel Piping, NPS 2 (DN 50) and Smaller: Threaded ends.
 - e. For Steel Piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules below.
 - f. For Steel Piping, NPS 5 (DN 125) and Larger: Flanged ends.
 - g. For Grooved-End Steel Piping: Valve ends may be grooved.

3.04 VALVE SCHEDULE

VALVE SCHEDULE								
APPLICATION		VALVE SPECIFICATION						
Service	Maximum Press	G-1, GL-1, CH-1	G-1, G-2, GL-2, CH-2, Ch-2A	G-3, G-4, GL-3, CH-3	G-5, G-6, GL-4, CH-4	SSB-1	B-1, B-2, B-3, B-4	BF-1, BF-1A

								SSBF-1
							See Note #1	See Note #2 and #3
Domestic Water (Cold, Hot and Hot Water Return)								
Copper, 2" & smaller	200 psi, WOG						X	
	300 psi, WOG						X	
	600 psi, WOG						X	
Stainless Steel, 2" and Smaller	200 psi, WOG					X		
Copper, 2- 1/2" & larger	600 psi, WOG		X				X	
Stainless Steel, 2- 1/2" & larger	300 psi up to 8"							
	200 psi 10" and over				X			X
Galvanized Steel, 2- 1/2" & Larger	200 psi, CWP			X				X(150)
	500 psi, CWP				X			
Sanitary-Waste								
Copper, 2" & smaller	200 psi, WOG	X						
	300 psi, WOG			X				
	600 psi, WOG						X	
Copper, 2- 1/2" & larger	600 psi, WOG						X	
Galvanized Steel, 2- 1/2" & Larger	200 psi, CWP			X				
	500 psi, CWP				X			
Storm Drainage								
Copper, 2" & smaller	200 psi, WOG	X						
	300 psi, WOG			X				

	600 psi, WOG						X	
Copper, 2- 1/2" & larger	600 psi, WOG						X	
Galvanized Steel, 2- 1/2" & Larger	200 psi, CWP			X				
	500 psi, CWP				X			
Compressed Air (Low Pressure - 150psig or less)								
	200 psi, WOG	X						
Copper, 2" & smaller	300 psi, WOG			X				
	600 psi, WOG						X	
Copper, 2- 1/2" & larger	600 psi, WOG						X	
Carbon Steel, 2- 1/2" & Larger	200 psi, CWP			X				
	500 psi, CWP				X			
Compressed Air (High Pressure - 150psig to 200psig)								
	200 psi, WOG	X						
Copper, 2" & smaller	300 psi, WOG			X				
	600 psi, WOG						X	
Copper, 2- 1/2" & larger	600 psi, WOG						X	
Carbon Steel, 2- 1/2" & Larger	200 psi, CWP			X				
	500 psi, CWP				X			
Note #1: 3-piece valve for by-pass service.								
Note #2: Maximum working pressure shown in parentheses for butterfly valves.								
Note #3: BF-1 and BF-2 are not allowed in stainless steel piping systems.								

END OF SECTION

SECTION 22 05 93
TESTING, ADJUSTING, AND BALANCING FOR PLUMBING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. TAB of domestic water system.

1.02 GENERAL REFERENCES

- A. Contract Documents: Refer to complete set of Contract Documents for requirements that are related to or may affect the work described in this Section.
- B. Division 20, including all Common Mechanical Requirements in Section 20 00 00, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.

1.03 REFERENCE STANDARDS

- A. ASHRAE Std 111 - Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems; 2024, with Errata (2025).

1.04 ABBREVIATIONS AND ACRONYMS

- A. AABC: Associated Air Balance Council.
- B. NEBB: National Environmental Balancing Bureau.
- C. TAB: Testing, adjusting, and balancing.
- D. TABB: Testing, Adjusting, and Balancing Bureau.
- E. TAB Specialist: An independent entity meeting qualifications to perform TAB work.
- F. TDH: Total dynamic head.
 - 1. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
 - 2. Contract Documents Examination Report: Within 30 days of Contractor's Notice to Proceed, submit the Contract Documents review report, as specified in Part 3.
 - 3. Strategies and Procedures Plan: Within 30 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures, as specified in "Preparation" Article.
 - 4. System Readiness Checklists: Within 30 days of Contractor's Notice to Proceed, submit system readiness checklists, as specified in "Preparation" Article.
 - 5. Examination Report: Submit a summary report of the examination review required in "Examination" Article.
 - 6. Certified TAB reports.
 - 7. Sample report forms.
 - 8. Instrument calibration reports, to include the following:
 - a. Instrument type and make.
 - b. Serial number.
 - c. Application.
 - d. Dates of use.
 - e. Dates of calibration.

1.05 QUALITY ASSURANCE

- A. TAB Specialists Qualifications, Certified by NEBB or TABB:
 - 1. TAB Field Supervisor: Employee of the TAB specialist and certified by NEBB or TABB.
 - 2. TAB Technician: Employee of the TAB specialist and certified by NEBB or TABB.
- B. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE Std 111, Section 4, "Instrumentation."

- C. ASHRAE Std 111 Compliance: Requirements in ASHRAE Std 111 applicable to analogous domestic water system and plumbing equipment balancing.
- D. ASHRAE 188 Compliance: Comply with balancing and report requirements, Section 8.3 "Balancing."
- E. Code and Authorities Having Jurisdiction Compliance: TAB is required to comply with governing codes and requirements of authorities having jurisdiction.

1.06 PRE-INSTALLATION TESTING

- A. Pre-Installation Meetings:
 - 1. TAB Conference: Conduct a TAB conference after approval of the TAB strategies and procedures plan, to develop a mutual understanding of the details. Provide a minimum of 14 days' advance notice of scheduled meeting time and location.
 - a. Minimum Agenda Items:
 - 1) The Contract Documents examination report.
 - 2) The TAB plan.
 - 3) Needs for coordination and cooperation of trades and subcontractors.
 - 4) Proposed procedures for documentation and communication flow.

1.07 FIELD CONDITIONS

- A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.
- B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.
- B. Examine installed systems for balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices, and balancing valves and fittings. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.
- C. Examine approved submittals for plumbing systems and equipment.
- D. Examine design data, including plumbing system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about plumbing system and equipment controls.
- E. Examine equipment performance data, including pump curves.
 - 1. Relate performance data to Project conditions and requirements, including pump system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
 - 2. Calculate pump system-effect factors to reduce performance ratings of plumbing equipment when installed under conditions different from the conditions used to rate equipment performance. Compare results with the design data and installed conditions.
- F. Examine system and equipment installations, and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- G. Examine test reports specified in individual system and equipment Sections.
- H. Examine plumbing equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.

- I. Examine temporary and permanent strainers. Verify that temporary strainer screens used during system cleaning and flushing have been removed and permanent strainers are installed and clean.
- J. Examine control valves for proper installation for their intended function of isolating, throttling, diverting, or mixing fluid flows.
- K. Examine system pumps to ensure absence of entrained air in the suction piping.
- L. Examine operating safety interlocks and controls on plumbing equipment.
- M. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.02 PREPARATION

- A. Prepare a TAB plan that includes the following:
 - 1. Equipment and systems to be tested.
 - 2. Strategies and step-by-step procedures for balancing the systems.
 - 3. Instrumentation to be used.
 - 4. Sample forms with specific identification for all equipment.
- B. Perform system-readiness checks of plumbing systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:
 - 1. Domestic Water System:
 - a. Verify leakage and pressure tests on water distribution systems have been satisfactorily completed in accordance with applicable code and authority having jurisdiction.
 - b. Water heaters are installed and functioning.
 - c. Piping is complete and all points of outlet are installed.
 - d. Water treatment is complete.
 - e. Systems are flushed, filled, and air purged.
 - f. Strainers are clean.
 - g. Control valves are functioning in accordance with the sequence of operation.
 - h. Shutoff and balance valves are 100 percent open.
 - i. Booster- and hot-water circulating pumps are operational and proper rotation is verified.
 - j. Pump gauge connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.
 - k. Variable-frequency controllers' startup is complete and safeties are verified.
 - l. Suitable access to balancing devices and equipment is provided.
 - 2. Sanitary Sewage/Drainage System:
 - a. Leakage and pressure tests on sanitary sewage/drainage systems have been completed in accordance with applicable code and authority having jurisdiction requirements.
 - b. Piping is complete.
 - c. Sanitary sewage pumps/drainage pumps are operational.
 - d. Control valves are functioning in accordance with the sequence of operation.
 - e. Shutoff valves are 100 percent open.
 - f. Suitable access to equipment is provided.
 - 3. Compressed-Air System:
 - a. Leakage and pressure tests on compressed air distribution system have been satisfactorily completed in accordance with Division 22 requirements.
 - b. Piping is complete and all points of outlet are installed.
 - c. Systems are flushed, filled, and air purged.
 - d. Strainers are clean.

- e. Control valves are functioning in accordance with the sequence of operation.
 - f. Shutoff and balance valves are 100 percent open.
 - g. Compressors are operational and of proper rotation.
 - h. Gauge connections are installed directly at compressor inlet and outlet flanges prior to valves or strainers.
 - i. Variable-frequency controllers' startup is complete and safeties are verified.
 - j. Suitable access to balancing devices and equipment is provided,
4. Vacuum System:
- a. Leakage and pressure tests on vacuum system have been satisfactorily completed in accordance with Division 22 requirements.
 - b. Piping is complete and all points of inlet are installed.
 - c. Systems are flushed, filled, and purged.
 - d. Strainers are clean.
 - e. Control valves are functioning in accordance with the sequence of operation.
 - f. Shutoff and balance valves are 100 percent open.
 - g. Vacuum pumps are operational and of proper rotation.
 - h. Gauge connections are installed directly at vacuum pump inlet and outlet flanges prior to valves or strainers.
 - i. Variable-frequency controllers' startup is complete and safeties are verified.
 - j. Suitable access to balancing devices and equipment is provided.

3.03 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system in accordance with the procedures contained in ASHRAE Std 111 and in this Section.
- B. Cut insulation, pipes, and equipment casings for installation of test probes to the minimum extent necessary for TAB procedures.
 - 1. Where holes for probes are required in piping or equipment, install pressure and temperature test plugs to seal systems.
 - 2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish in accordance with Division 20 Section Mechanical Insulation.
- C. Mark equipment and balancing devices, including valve position indicators and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.04 GENERAL PROCEDURES FOR PLUMBING EQUIPMENT

- A. Test, adjust, and balance plumbing equipment indicated on Drawings, including, but not limited to, the following:
 - 1. Motors.
 - 2. Domestic water booster pumps.
 - 3. Domestic water in-line pumps.
 - 4. Domestic water heaters.
 - 5. Sanitary sewage pumps.
 - 6. Drainage pumps.
 - 7. Air compressors.
 - 8. Vacuum pumps.

3.05 PROCEDURES FOR DOMESTIC WATER SYSTEMS

- A. Prepare test reports for pumps and other equipment. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required equipment flow rates with system design flow rates.

- B. Prepare schematic diagrams of systems' Record drawings piping layouts.
- C. In addition to requirements in "Preparation" Article, prepare domestic water systems for testing and balancing as follows:
 - 1. Check expansion tank for proper setting.
 - 2. Check water heater for proper discharge temperature setting.
 - 3. Check remotest point of outlet for adequate pressure.
 - 4. Check flow-control valves for proper position.
 - 5. Locate start-stop and disconnect switches, electrical interlocks, and motor controllers.
 - 6. Verify that motor controllers are equipped with properly sized thermal protection.
 - 7. Check that air has been purged from the system.
- D. Measure and record upstream and downstream pressure of each piece of equipment.
- E. Measure and record upstream and downstream pressure of pressure-reducing valves.
- F. Check settings and operation of automatic temperature-control valves, self-contained control valves, and pressure-reducing valves. Record final settings.
- G. Check settings and operation of each safety valve. Record settings.

3.06 PROCEDURES FOR COMPRESSED-AIR SYSTEMS

- A. Prepare test reports for air compressors, and other equipment. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required equipment flow rates with system design flow rates.
- B. Prepare schematic diagrams of systems' Record drawings piping layouts.
- C. In addition to requirements in "Preparation" Article, prepare compressed-air systems for testing and balancing as follows:
 - 1. Check remotest point of outlet for adequate pressure.
 - 2. Check pressure-control valves for proper position.
 - 3. Locate start-stop and disconnect switches, electrical interlocks, and motor controllers.
 - 4. Verify that motor controllers are equipped with properly sized thermal protection.
- D. Measure and record upstream and downstream pressure of pressure-reducing valves.
- E. Check settings and operation of pressure-reducing valves. Record final settings.
- F. Check settings and operation of each safety valve. Record settings.

3.07 PROCEDURES FOR VACUUM SYSTEMS

- A. Prepare test reports for vacuum pumps and other equipment. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required equipment flow rates with system design flow rates.
- B. Prepare schematic diagrams of systems' Record drawings piping layouts.
- C. In addition to requirements in "Preparation" Article, prepare domestic water systems for testing and balancing as follows:
 - 1. Check remotest point of inlet for adequate vacuum.
 - 2. Locate start-stop and disconnect switches, electrical interlocks, and motor controllers.
 - 3. Verify that motor controllers are equipped with properly sized thermal protection.

3.08 PROCEDURES FOR DOMESTIC WATER SYSTEM BOOSTER PUMPS

- A. Adjust pumps to deliver total design flow.
 - 1. Measure total water flow.
 - a. Position valves for full flow through coils.
 - b. Measure flow by main flow meter, if installed.
 - c. If main flow meter is not installed, determine flow by pump TDH or known equipment pressure drop.

2. Measure pump TDH as follows:
 - a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
 - b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
 - c. Convert pressure to head and correct for differences in gauge heights.
 - d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow, and verify that the pump has the intended impeller size.
 - e. With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved. If excessive throttling is required to achieve desired flow, recommend pump impellers be trimmed to reduce excess throttling.
 3. Monitor motor performance during procedures, and do not operate motor in an overloaded condition.
- B. Adjust flow-measuring devices installed in mains and branches to design water flows.
1. Measure flow in main and branch pipes.
 2. Adjust main and branch balance valves for design flow.
 3. Re-measure each main and branch after all have been adjusted.
- C. Verify final system conditions as follows:
1. Re-measure and confirm that total water flow is within design.
 2. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
 3. Mark final settings.
- D. Verify that memory stops have been set.

3.09 PROCEDURES FOR DOMESTIC HOT-WATER CIRCULATING INLINE PUMP

- A. Balance system with manual or automatic balancing valves by setting at design flow.
1. Balance and adjust all main and branch balance valves for to ensure adequate flow for domestic hot water temperature maintenance.
 2. Measure flow in main and branch pipes.
 3. Balance and adjust all main and branch balance valves for to ensure adequate flow for domestic hot water temperature maintenance.
 4. Re-measure each main and branch after all have been adjusted.
 5. Record flow and balance valve set point in TAB report
- B. Adjust pump to deliver total design flow.
1. Measure pump TDH as follows:
 - a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
 - b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
 - c. Convert pressure to head and correct for differences in gauge heights.
 - d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow, and verify that the pump has the intended impeller size.
 2. Monitor motor performance during procedures, and do not operate motor in an overloaded condition.
 3. Mark final settings and verify that all memory stops have been set.
 4. Verify final system conditions as follows:
 - a. Re-measure and confirm that total flow is within design.
 - b. Re-measure final pumps' operating data, TDH, volts, amps, speed, and static profile.
 - c. Mark final settings.

3.10 PROCEDURES FOR MOTORS

- A. Motors 1/2 HP and Larger: Test at final balanced conditions and record the following data:
 - 1. Manufacturer's name, model number, and serial number.
 - 2. Motor horsepower rating.
 - 3. Motor rpm.
 - 4. Phase and hertz.
 - 5. Nameplate and measured voltage, each phase.
 - 6. Nameplate and measured amperage, each phase.
 - 7. Starter size and thermal-protection-element rating.
 - 8. Service factor and frame size.
- B. Motors Driven by Variable-Frequency Controllers: Test manual bypass of controller to prove proper operation.

3.11 PROCEDURES FOR WATER HEATERS

- A. Electric Water Heaters:
 - 1. Measure and record entering- and leaving-water temperatures.
 - 2. Measure and record water flow.
 - 3. Measure and record pressure drop.
 - 4. Measure and Record relief valve(s) pressure setting.
 - 5. Capacity: Calculate in Btu/h of heating output.
 - 6. Efficiency: Calculate operating efficiency for comparison to submitted equipment.
- B. Gas- and Oil-Fired Water Heaters:
 - 1. Measure and record entering- and leaving-water temperatures.
 - 2. Measure and record water flow.
 - 3. Measure and record pressure drop.
 - 4. Measure and Record relief valve(s) pressure setting.
 - 5. Capacity: Calculate in Btu/h of heating output.
 - 6. Fuel Consumption: If fuel supply is equipped with flow meter, measure and record consumption.
 - 7. Efficiency: Calculate operating efficiency for comparison to submitted equipment.
 - 8. Fan, motor, and motor controller operating data.

3.12 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

- A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.
 - 1. Measure and record flows, temperatures, and pressures of each piece of equipment. Compare the values to design or nameplate information, where information is available.
 - 2. Measure motor voltage and amperage. Compare the values to motor nameplate information.
 - 3. Check the condition of filters.
 - 4. Check bearings and other lubricated parts for proper lubrication.
 - 5. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.
- B. TAB After Construction: Before performing testing and balancing of renovated existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished in accordance with renovation scope indicated by Contract Documents. Verify the following:
 - 1. New filters are installed.
 - 2. Bearings and other parts are properly lubricated.
 - 3. Deficiencies noted in the preconstruction report are corrected.
- C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.

1. Compare the indicated system flows of the renovated work to the measured flows, and determine the new pump speed.
2. Verify that the indicated system flows of the renovated work result in velocities and pump speeds that are within the acceptable limits defined by equipment manufacturer.
3. If calculations increase or decrease the system flow rates by more than 5 percent, make equipment adjustments to achieve the calculated rates. If increase or decrease is 5 percent or less, equipment adjustments are not required.

3.13 TOLERANCES

- A. Set plumbing system's flow rates within the following tolerances:
 1. Domestic Water Flow Rate: Plus or minus 5 percent. If design value is less than 10 gpm, within 10 percent.
 2. Compressed-Air Flow Rate: Plus or minus 5 percent. If design value is less than 10 gpm, within 10 percent.
 3. Vacuum Flow Rate: Plus or minus 5 percent.

3.14 PROGRESS REPORTING

- A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for system-balancing devices. Recommend changes and additions to system-balancing devices, to facilitate proper performance measuring and balancing. Recommend changes and additions to plumbing systems and general construction to allow access for performance-measuring and -balancing devices.
- B. Status Reports: Prepare biweekly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.15 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
 1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing Engineer.
 2. Include a list of instruments used for procedures, along with proof of calibration.
 3. Certify validity and accuracy of field data.
- B. Final Report Contents: In addition to certified field-report data, include the following:
 1. Pump curves.
 2. Manufacturers' test data.
 3. Field test reports prepared by system and equipment installers.
 4. Other information relative to equipment performance; do not include Shop Drawings and Product Data.
- C. General Report Data: In addition to form titles and entries, include the following data:
 1. Title page.
 2. Name and address of the TAB specialist.
 3. Project name.
 4. Project location.
 5. Bid Opening Time's name and address.
 6. Engineer's name and address.
 7. Contractor's name and address.
 8. Report date.
 9. Signature of TAB supervisor who certifies the report.
 10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.

11. Summary of contents, including the following:
 - a. Indicated versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
12. Nomenclature sheets for each item of equipment.
13. Notes to explain why certain final data in the body of reports vary from indicated values.
14. Test conditions for pump performance forms, including the following:
 - a. Variable-frequency controller settings for variable-flow hydronic systems.
 - b. Settings for pressure controller(s).
 - c. Other system operating conditions that affect performance.
- D. System Diagrams: Include schematic layouts of distribution systems. Present each system with single-line diagram and include the following:
 1. Flow rates.
 2. Pipe and valve sizes and locations.
 3. Balancing stations.
 4. Position of balancing devices.
- E. Gas- and Oil-Fired Water Heaters Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:
 1. Unit Data:
 - a. System identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and unit size.
 - e. Manufacturer's serial number.
 - f. Fuel type in input data.
 - g. Output capacity in Btu/h.
 - h. Ignition type.
 - i. Burner-control types.
 - j. Motor horsepower and speed.
 - k. Motor volts, phase, and hertz.
 - l. Motor full-load amperage and service factor.
 - m. Sheave make, size in inches, and bore.
 - n. Center-to-center dimensions of sheave and amount of adjustments in inches.
 2. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cfm.
 - b. Entering-water temperature in deg F.
 - c. Leaving-water temperature in deg F.
 - d. Low-fire fuel input in Btu/h.
 - e. High-fire fuel input in Btu/h.
 - f. High-temperature-limit setting in deg F.
 - g. Operating set point in Btu/h.
 - h. Heating value of fuel in Btu/h.
- F. Electric Water Heater Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:
 1. Unit Data:
 - a. System identification.
 - b. Location.
 - c. Model number and unit size.
 - d. Manufacturer's serial number.
 - e. Output capacity in Btu/h.
 - f. Number of stages.

- g. Connected volts, phase, and hertz.
 - h. Rated amperage.
 - 2. Test Data (Indicated and Actual Values):
 - a. Heat output in Btu/h.
 - b. Entering-water temperature in deg F.
 - c. Leaving-water temperature in deg F.
 - d. High-temperature-limit setting in deg F.
 - e. Operating set point in deg F.
 - f. Voltage at each connection.
 - g. Amperage for each phase.
- G. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves, and include the following:
 - 1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Service.
 - d. Make and size.
 - e. Model number and serial number.
 - f. Water flow rate in gpm.
 - g. Water-pressure differential in feet of head or psig.
 - h. Required net positive suction head in feet of head or psig.
 - i. Pump speed.
 - j. Impeller diameter in inches.
 - k. Motor make and frame size.
 - l. Motor horsepower and rpm.
 - m. Voltage at each connection.
 - n. Amperage for each phase.
 - o. Full-load amperage and service factor.
 - p. Seal type.
 - 2. Test Data (Indicated and Actual Values):
 - a. Static head in feet of head or psig.
 - b. Pump shutoff pressure in feet of head or psig.
 - c. Actual impeller size in inches.
 - d. Full-open flow rate in gpm.
 - e. Full-open pressure in feet of head or psig.
 - f. Final discharge pressure in feet of head or psig.
 - g. Final suction pressure in feet of head or psig.
 - h. Final total pressure in feet of head or psig.
 - i. Final water flow rate in gpm.
 - j. Voltage at each connection.
 - k. Amperage for each phase.
- H. Instrument Calibration Reports:
 - 1. Report Data:
 - a. Instrument type and make.
 - b. Serial number.
 - c. Application.
 - d. Dates of use.
 - e. Dates of calibration.

3.16 VERIFICATION OF TAB REPORT

- A. The TAB specialist's test and balance Engineer shall conduct the inspection in the presence of Construction Manager or Commissioning Authority.
- B. Construction Manager or Commissioning Authority shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to the lesser of either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
- C. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
- D. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the TAB shall be considered incomplete and shall be rejected.
- E. If recheck measurements find the number of failed measurements noncompliant with requirements indicated, proceed as follows:
 - 1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection. All changes shall be tracked to show changes made to previous report.
 - 2. If the second final inspection also fails, Project Address 2 may pursue other Contract options to complete TAB work.
- F. Prepare test and inspection reports.

3.17 ADDITIONAL TESTS

- A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

END OF SECTION

**SECTION 22 10 05
PLUMBING PIPING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Domestic Water Piping
 - 1. Copper Tube and Fittings.
 - 2. Stainless-Steel Piping.
 - 3. Piping Joining Materials.
 - 4. Transition Fittings.
 - 5. Dielectric Fittings.
 - 6. Flexible Connectors.
- B. Sanitary Waste and Vent Piping
 - 1. Copper Tube and Fittings.
 - 2. PVC Pipe and Fittings.
 - 3. Hubless, Cast-iron Soil Pipe and Fittings.
 - 4. High performance coated hubless, cast-iron soil pipe and fittings.
 - 5. Transition Fittings.
 - 6. Dielectric Fittings.
- C. Encasement for Underground Metal Piping

1.02 GENERAL REFERENCES

- A. Contract Documents: Refer to complete set of Contract Documents for requirements that are related to or may affect the work described in this Section.
- B. Division 20, including all Common Mechanical Requirements in Section 20 00 00, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.

1.03 REFERENCE STANDARDS

- A. ASCE/SEI 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures; 2016.
- B. ASME A112.3.1 - Stainless Steel Drainage Systems for Sanitary DWV, Storm, & Vacuum Applications Above & Below Ground; 2007 (R2022).
- C. ASME B1.20.1 - Pipe Threads, General Purpose, Inch; 2013 (Reaffirmed 2018).
- D. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2021.
- E. ASME B16.21 - Nonmetallic Flat Gaskets for Pipe Flanges; 2021.
- F. {RSTEMP#367}ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; The American Society of Mechanical Engineers{CH#82718}.
- G. ASME B16.23 - Cast Copper Alloy Solder Joint Drainage Fittings: DWV; 2021.
- H. ASME B16.24 - Cast Copper Alloy Pipe Flanges, Flanged Fittings, and Valves: Classes 150, 300, 600, 900, 1500, and 2500; 2021.
- I. ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder-Joint Drainage Fittings—DWV; 2022.
- J. ASME B16.45 - Cast Iron Fittings for Solvent Drainage Systems; Approved Edition.
- K. ASME B16.51 - Copper and Copper Alloy Press-Connect Pressure Fittings; 2021.
- L. ASME B18.2.1 - Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series); 2012 (Reaffirmed 2021).
- M. ASME B31.9 - Building Services Piping; 2020.

- N. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators; 2025, with Errata.
- O. ASSE 1061 - Performance Requirements for Push-Fit Fittings; Approved Edition.
- P. ASSE 1079 - x; x.
- Q. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings; Approved Edition.
- R. ASTM A312/A312M - Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes; 2022a.
- S. ASTM A674 - Standard Practice for Polyethylene Encasement for Ductile Iron Pipe; 2022.
- T. ASTM A815/A815M - x; x.
- U. ASTM A888 - Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications; Approved Edition.
- V. ASTM B29 - Standard Specification for Refined Lead; 2019.
- W. ASTM B32 - Standard Specification for Solder Metal; 2000.
- X. ASTM B75/B75M - Standard Specification for Seamless Copper Tube; 2020.
- Y. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2022.
- Z. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2022.
- AA. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric); 2020.
- BB. ASTM B306 - Standard Specification for Copper Drainage Tube (DWV); 2020.
- CC. ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications; 2022.
- DD. ASTM B813 - Standard Specification for Water Flushable Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube; 2024.
- EE. ASTM B828 - Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings; Approved Edition.
- FF. ASTM C564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings; Approved Edition.
- GG. ASTM C1173 - Standard Specification for Flexible Transition Couplings for Underground Piping Systems; Approved Edition.
- HH. ASTM C1277 - Standard Specification for Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings; 2020.
- II. ASTM C1460 - Standard Specification for Shielded Transition Couplings for Use with Dissimilar DWV Pipe and Fittings Above Ground; Approved Edition.
- JJ. ASTM C1540 - Standard Specification for Heavy-Duty Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings; 2020.
- KK. ASTM D1248 - Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable; 2016.
- LL. ASTM D2000 - Standard Classification System for Rubber Products in Automotive Applications; 2018, with Editorial Revision (2024).
- MM. ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications; 2025.
- NN. ASTM D2564 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems; 2020 (Reapproved 2024).

- OO. ASTM D2661 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe and Fittings; 2024.
- PP. ASTM D2665 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings; 2024.
- QQ. ASTM D2846/D2846M - Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Hot- and Cold-Water Distribution Systems; 2024.
- RR. ASTM D3311 - Standard Specification for Drain, Waste, and Vent (DWV) Plastic Fittings Patterns; 2017 (Reapproved 2021).
- SS. ASTM D5926 - Standard Specification for Poly (Vinyl Chloride) (PVC) Gaskets for Drain, Waste, and Vent (DWV), Sewer, Sanitary, and Storm Plumbing Systems; Approved Edition.
- TT. ASTM E84 - Standard Test Method for Surface Burning; x.
- UU. ASTM F402 - Standard Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings; 2018.
- VV. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe; 2014 (Reapproved 2021).
- WW. ASTM F493 - Standard Specification for Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings; 2022.
- XX. ASTM F656 - x; x.
- YY. ASTM F1545 - x; x.
- ZZ. ASTM F1807 - Standard Specification for Metal Insert Fittings Utilizing a Copper Crimp Ring, or Alternate Stainless Steel Clamps, for SDR9 Cross-Linked Polyethylene (PEX) Tubing and SDR9 Polyethylene of Raised Temperature (PE-RT) Tubing; 2023.
- AAA. ASTM F1960 - Standard Specification for Cold Expansion Fittings with PEX Reinforcing Rings for Use with Cross-Linked Polyethylene (PEX) and Polyethylene of Raised Temperature (PE-RT) Tubing; 2024.
- BBB. ASTM F2014 - Standard Specification for Non-Reinforced Extruded Tee Connections for Piping Applications; Approved Edition.
- CCC. AWS A5.8/A5.8M - Specification for Filler Metals for Brazing and Braze Welding; American Welding Society; Approved Edition.
- DDD. AWWA C105/A21.5 - Polyethylene Encasement for Ductile-Iron Pipe Systems; 2018.
- EEE. AWWA C110/A21.10 - Ductile-Iron and Gray-Iron Fittings; 2021.
- FFF. AWWA C219 - Bolted Sleeve-Type Couplings for Plain-End Pipe; 2023.
- GGG. AWWA C600 - Installation of Ductile-Iron Mains and Their Appurtenances; 2023.
- HHH. 40 CFR 59, Subpart D - National Volatile Organic Compound Emission Standards for Architectural Coatings; U.S. Environmental Protection Agency; Current Edition.
- III. AWWA C606 - Grooved and Shouldered Joints; 2022.
- JJJ. AWWA C651 - Disinfecting Water Mains; 2023.
- KKK. AWWA C652 - Disinfection of Water-Storage Facilities; 2019.
- LLL. AWWA M41 - Ductile-Iron Pipe and Fittings; 2009.
- MMM. CISPI 301 - Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications; 2021.
- NNN. IAPMO PS 66 - x; x.
- OOO. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2018, with Amendment (2019).

- PPP. MSS SP-69 - Pipe Hangers And Supports - Selection And Application; Approved Edition.
- QQQ. MSS SP-123 - Non-Ferrous Threaded and Solder-Joint Unions for Use With Copper Water Tube; Approved Edition.
- RRR. NFPA 262 - Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces; 2023.
- SSS. NSF 14 - Certification of Plastic Piping Products; Approved Edition.
- TTT. NSF 61 - Drinking Water System Components - Health Effects; 2024.
- UUU. NSF 372 - Drinking Water System Components - Lead Content; 2024.
- VVV. UL 1887 - x; x.

1.04 PERFORMANCE REQUIREMENTS

- A. Domestic Water Piping
1. Domestic water piping, tubing, fittings, and appurtenances intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act, with requirements of authorities having jurisdiction, and with NSF 61 and NSF 372, or be certified in compliance with NSF 61 and NSF 372 by an ANSI-accredited third-party certification body, in that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.
- B. Sanitary Waste and Vent Piping
1. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
 - a. Soil, Waste, and Vent Piping: 10 foot (3 m) head of water.
 - b. Waste, Force-Main Piping: 50 psig (345 kPa).
 2. Seismic Performance: Soil, waste, and vent piping and support and installation shall withstand the effects of earthquake motions determined according to ASCE/SEI 7. Refer to Section 20 05 48 - Vibration and Seismic Controls.
 - a. The term "withstand" means "the unit shall remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit shall be fully operational after the seismic event."
 - b. Component Importance Factor: 1.5.
 3. Product Data:
 - a. Pipe and tube.
 - b. Fittings.
 - c. Joining materials.
 - d. Transition fittings.
 4. Installers of pressure-sealed joints shall submit proof of manufacturer certification for installation of pressure-sealed joints.
 5. Shop Drawings: For hubless, single-stack drainage system. Include plans, elevations, sections, and details.
 6. Shop Drawings: For Soveint drainage system. Include plans, elevations, sections, and details.
 7. Shop Drawings: For controlled-flow or siphonic roof drainage system. Include calculations, plans, and details.
 8. Coordination Drawings: Plans and elevations or Building Information Model (BIM) as indicated in Division 01 drawn to scale, showing items described in this Section and coordinated with all building trades.
 9. Coordination Drawings: Detail sanitary, waste, and storm drainage piping. Show support locations, type of support, weight on each support, required clearances, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - a. Structural members to which drainage piping will be attached or suspended from.

10. System purging and disinfecting activities report.
11. Seismic Qualification Certificates: For waste and vent piping, accessories, and components, from manufacturer.
 - a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - b. Detailed description of piping anchorage devices on which the certification is based and their installation requirements.
12. Field Quality-Control Reports: Inspection reports signed by authorities having jurisdiction.
13. Sustainable Design Submittals:
 - a. Product Data: For solvent cements, adhesive primers, and adhesives, indicating VOC content.
 - b. Laboratory Test Reports: For solvent cements, adhesive primers, and adhesives, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers"

1.05 WARRANTIES

- A. Listed manufacturers to provide labeling and warranty of their respective products.

1.06 QUALITY ASSURANCE

- A. Welding Materials and Procedures: Comply with ASME BPVC-IX and applicable state labor regulations.
- B. Welder Qualifications: Certified in accordance with ASME BPVC-IX.
- C. Installer Qualifications: Installers of pressure-sealed domestic water piping joints are to be certified by pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.
- D. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- E. Each pipe shall be marked with manufacturer's name or registered trademark, county of origin, and date of manufacture.
- F. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

1.07 DELIVERY, STORAGE AND HANDLING

- A. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- B. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.
- C. Follow Project Location recommendations for storage.

1.08 FIELD CONDITIONS

- A. Do not install underground piping when bedding is wet or frozen.
- B. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:
 1. Notify Bid Opening Time Engineer no fewer than two days in advance of proposed interruption of water service.
 2. Coordinate interruption of combined domestic water / fire protection service with local fire marshall. Do not interrupt combined water service without fire marshall approval.
 3. Do not interrupt water service without Bid Opening Time 's Engineer 's written permission.

- C. Interruption of Existing Sanitary Waste Service: Do not interrupt service facilities occupied by Project Address 2 or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
 - 1. Notify Engineer no fewer than two days in advance of proposed interruption of sanitary waste service.
 - 2. Do not interrupt sanitary waste service without Bid Opening Time 's Engineer 's written permission.
- D. Interruption of Existing Storm Drainage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
 - 1. Notify Bid Opening Time Engineer no fewer than two days in advance of proposed interruption of storm drainage service.
 - 2. Do not proceed with interruption of storm drainage service without Bid Opening Time 's written permission.

PART 2 PRODUCTS

2.01 GENERAL

- A. Piping Materials
 - 1. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.
 - 2. Potable-water piping and components shall comply with NSF 14, NSF 61 and NSF 372. Potable water plastic piping components shall be marked with "NSF-pw."

2.02 DOMESTIC WATER PIPING

- A. Copper Tube and Fittings
 - 1. Drawn-Temper "Hard" Copper Tube: ASTM B88 , Type K water tube.
 - 2. Annealed "Soft" Copper Tube: ASTM B88 , Type K water tube.
 - 3. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings. Do not use solder joints on pipe sizes greater than NPS 3 (DN 75).
 - 4. Wrought-Copper, Solder-Joint Fittings: {RS#367}, pressure fittings. Do not use solder joints on pipe sizes greater than NPS 3 (DN 75).
 - 5. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends. Do not use solder joints on pipe sizes greater than NPS 3 (DN 75).
 - 6. Cast Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends. Do not use solder joints on pipe sizes greater than NPS 3 (DN 75).
 - 7. As an alternate, and only if submitted with proper alternate bid procedures as defined in Division 01 and Division 20 Specification Sections, and if permitted by the owner and local authorities, copper pipe may be mechanically joined by proprietary copper or bronze press-connect fittings as manufactured by Viega or NIBCO (no other manufacturers accepted). Fittings shall conform to the material and sizing requirements of ASME B16.18 or {RS#367} and ASME B16.51. The elastomeric seal shall be made of a non-toxic synthetic EPDM rubber that meets the requirements of ASTM D2000.
 - a. Source Limitations: Obtain press-connect fittings from one manufacturer only.
 - b. Use shall be limited to systems with maximum operating pressure of 200 psi, and maximum operating temperature of 250 degrees.
 - c. Air and/or hydrostatic testing to identify unpressed joints or leaks will be done in compliance with Viega or NIBCO recommended testing requirements and protocols. After completion of successful leak test, system may be charged to pressure mandated per local code.
 - d. Fittings 1/2 inch to 2 inch (13 mm to 50 mm) shall be pressed on both sides of an integral bead containing an EPDM seal. Fittings 2-1/2 inch to 4 inch (63 mm to 100

- mm) shall be pressed per manufacturer recommended installation protocols for Viega or NIBCO.
- e. Upon completion of the Work, furnish to Owner one (1) press toolkit, with interchangeable jaws, chains, and rings for each pipe size included in the Work per Viega or NIBCO provided tool and jaw compatibility matrix. Instruct Owner in proper use of press tool.
 - f. Installers shall be licensed within the jurisdiction and familiar with the installation of Viega Pro-Press or NIBCO, INC press-connect fitting systems. Installers shall attend Viega's or NIBCO's installation training class or provide proof of having been trained and qualified to join piping with Viega or NIBCO press-connect fittings and be able to furnish proof at the request of the AHJ.
 - g. In addition to the installation requirements specified herein, press-connect bronze or copper fittings shall be installed in accordance with the latest edition of Viega's or NIBCO's installation instructions using the proper tool, jaws, rings, and actuators as recommended by Viega or NIBCO.
8. Copper-Tube, Extruded-Tee Connections:
 - 1) T-Drill Industries Inc.
 - b. Description: Tee formed in copper tube according to ASTM F2014.
9. Appurtenances for Grooved-End Copper Tubing:
 - 1) Anvil International.
 - 2) Grinnell Mechanical Products.
 - 3) Victaulic Company.
 - 4) Shurjoint Piping Products.
 - b. Source Limitations: Obtain grooved, mechanical-joint copper tube appurtenances from single manufacturer.
 - c. Grooved-End, Copper Fittings: ASTM B75/B75M copper tube or ASTM B584 bronze castings.
 - d. Grooved-End-Tube Couplings: To fit copper-tube dimensions; rigid pattern unless otherwise indicated; gasket fitting, EPDM-rubber gasket, UL classified per NSF 61 and NSF 372, and rated for minimum 180 deg F, for use with ferrous housing and steel bolts and nuts; 300 psig minimum CWP pressure rating.
 - 1) Coordinate the use of all lubricants with manufacturer requirements for the application.
- B. Stainless-Steel Piping
1. Potable-water piping and components shall comply with NSF 61 and NSF 372.
 2. Stainless-Steel Pipe: ASTM A312/A312M, with wall thickness as indicated in "Piping Applications" Article.
 3. Stainless-Steel Pipe Fittings: ASTM A815/A815M.
 4. Appurtenances for Grooved-End, Stainless-Steel Pipe:
 - 1) Anvil International.
 - 2) Grinnell Mechanical Products.
 - 3) Victaulic Company.
 - 4) Shurjoint Piping Products.
 - b. Fittings for Grooved-End, Stainless-Steel Pipe: Stainless-steel casting with dimensions matching stainless-steel pipe.
 - c. Mechanical Couplings for Grooved-End, Stainless-Steel Pipe:
 - 1) AWWA C606 for stainless-steel-pipe dimensions.
 - 2) Stainless-steel housing sections.
 - 3) Stainless-steel bolts and nuts.
 - 4) EPDM-rubber gaskets suitable for hot and cold water.
 - 5) Minimum Pressure Rating:
 - (a) NPS 8 (DN 200) and Smaller: 600 psig (4137 kPa).

- (b) NPS 10 and NPS 12 (DN 250 to DN 300): 400 psig (2758 kPa).
- (c) NPS 14 to NPS 24 (DN 350 to DN 600): 250 psig (1725 kPa).
- (1) Install backwater valves in accessible locations.

C. Piping Joining Materials

- 1. Pipe-Flange Gasket Materials:
 - a. AWWA C110/A21.10, rubber, flat face, 1/8 inch (3.2 mm) thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
 - b. Full-face or ring type unless otherwise indicated.
- 2. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- 3. Flux: ASTM B813, water flushable.
- 4. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.
- 5. Solvent Cements for Joining CPVC Piping and Tubing: ASTM F493.
 - a. CPVC solvent cement shall have a VOC content of 490 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - b. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - c. Solvent cement and adhesive primer shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- 6. Plastic, Pipe-Flange Gaskets, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

D. Transition Fittings

- 1. General Requirements:
 - a. Same size as pipes to be joined.
 - b. Pressure rating at least equal to pipes to be joined.
 - c. End connections compatible with pipes to be joined.
- 2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
- 3. Sleeve-Type Transition Coupling: AWWA C219.
 - 1) Cascade Waterworks Manufacturing.
 - 2) Dresser, Inc.; Piping Specialties Products.
 - 3) Ford Meter Box Company, Inc. (The).
 - 4) Jay R. Smith Mfg. Co.
 - 5) JCM Industries.
 - 6) Romac Industries, Inc.
 - 7) Smith-Blair, Inc.; a Sensus company.
 - 8) Viking Johnson.
- 4. Plastic-to-Metal Transition Fittings:
 - 1) Charlotte Pipe and Foundry Company.
 - 2) Harvel Plastics, Inc.
 - 3) Spears Manufacturing Company.
 - 4) Uponor.
 - b. Description:
 - 1) CPVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions.
 - 2) One end with threaded brass insert and one solvent-cement-socket end.
- 5. Plastic-to-Metal Transition Unions:
 - 1) Colonial Engineering, Inc.
 - 2) NIBCO Inc.

- 3) Spears Manufacturing Company.
 - b. Description:
 - 1) CPVC four-part union.
 - 2) Brass threaded end.
 - 3) Solvent-cement-joint or threaded plastic end.
 - 4) Rubber O-ring.
 - 5) Union nut.
 - E. Specialty Valves
 - 1. Comply with requirements in Division 22 Section 22 05 23 - General Duty Valves for Plumbing Piping for general-duty metal valves.
 - 2. Comply with requirements in Section 22 10 06 - Plumbing Piping Specialties for balancing valves, drain valves, backflow preventers, and vacuum breakers.
 - F. Dielectric Fittings
 - 1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
 - 2. Comply with the requirements of Section 20 05 00 - Common Mechanical Work Results.
 - 3. Comply with requirements in Section 22 05 23 - General Duty Valves for Plumbing Piping for general-duty metal valves.
 - 4. Comply with requirements in Section 22 10 06 - Plumbing Piping Specialties for balancing valves, drain valves, backflow preventers, and vacuum breakers.
 - 5. Dielectric Unions:
 - 1) Capitol Manufacturing Company; member of the Phoenix Forge Group.
 - 2) Central Plastics Company.
 - 3) Hart Industries International, Inc.
 - 4) Jomar International.
 - 5) Matco-Norca.
 - 6) McDonald, A. Y. Mfg. Co.
 - 7) Watts; a division of Watts Water Technologies, Inc.
 - 8) Wilkins; a Zurn company.
 - b. Standard: ASSE 1079.
 - c. Pressure Rating: 150 psig (1035 kPa).
 - d. End Connections: Solder-joint copper alloy and threaded ferrous.
 - 6. Dielectric Flanges:
 - 1) Capitol Manufacturing Company; member of the Phoenix Forge Group.
 - 2) Central Plastics Company.
 - 3) Matco-Norca.
 - 4) Watts; a division of Watts Water Technologies, Inc.
 - 5) Wilkins; a Zurn company.
 - b. Standard: ASSE 1079.
 - c. Factory-fabricated, bolted, companion-flange assembly.
 - d. Pressure Rating: 125 psig (860 kPa) minimum at 180 deg F (82 deg C).
 - e. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
7. Dielectric-Flange Insulating Kits:
 - 1) Advance Products & Systems, Inc.
 - 2) Calpico, Inc.
 - 3) Central Plastics Company.
 - 4) Pipeline Seal and Insulator, Inc.
- b. Nonconducting materials for field assembly of companion flanges.
- c. Pressure Rating: 150 psig (1035 kPa).

- d. Gasket: Neoprene or phenolic.
 - e. Bolt Sleeves: Phenolic or polyethylene.
 - f. Washers: Phenolic with steel backing washers.
 - 8. Dielectric Nipples:
 - 1) Elster Perfection Corporation.
 - 2) Grinnell Mechanical Products; Tyco Fire Products LP.
 - 3) Matco-Norca.
 - 4) Precision Plumbing Products, Inc.
 - 5) Victaulic Company.
 - b. Standard: IAPMO PS 66.
 - c. Electroplated steel nipple complying with ASTM F1545.
 - d. Pressure Rating and Temperature: 300 psig (2070 kPa) at 225 deg F (107 deg C).
 - e. End Connections: Male threaded or grooved.
 - f. Lining: Inert and noncorrosive, propylene.
- G. Flexible Connectors
- a. Flex-Hose Co., Inc.
 - b. Flexicraft Industries.
 - c. Flex Pression, Ltd.
 - d. Flex-Weld, Inc.
 - e. Hyspan Precision Products, Inc.
 - f. Mercer Rubber Co.
 - g. Metraflex, Inc.
 - h. Proco Products, Inc.
 - i. Tozen Corporation.
2. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
- a. Working-Pressure Rating: Minimum 200 psig (1380 kPa).
 - b. End Connections NPS 2 (DN 50) and Smaller: Threaded copper pipe or plain-end copper tube.
 - c. End Connections NPS 2-1/2 (DN 65) and Larger: Flanged copper alloy.
3. Stainless-Steel-Hose Flexible Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.
- a. Working-Pressure Rating: Minimum 200 psig (1380 kPa).
 - b. End Connections NPS 2 (DN 50) and Smaller: Threaded steel-pipe nipple.
 - c. End Connections NPS 2-1/2 (DN 65) and Larger: Flanged steel nipple.

2.03 SANITARY WASTE AND VENT PIPING

- A. Copper Tube and Fittings
- 1. Hard Copper Tube (DWV): ASTM B306
 - 2. Hard Copper Tube: ASTM B88, Type L (ASTM B88M, Type B), drawn temper.
 - 3. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.
 - 4. Copper Pressure Fittings:
 - a. Copper Fittings: ASME B16.18, cast-copper-alloy or {RS#367}, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
 - b. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
 - 5. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.
 - a. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.
 - b. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

6. Solder: ASTM B32, lead free with ASTM B813, water-flushable flux.
- B. PVC Pipe and Fittings
 1. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping.
 2. Solid-Wall PVC Pipe: ASTM D2665, drain, waste, and vent.
 3. PVC Socket Fittings: ASTM D2665, made to ASTM D3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
 4. Adhesive Primer: ASTM F656.
 - a. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - b. Adhesive primer shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
 5. Solvent Cement: ASTM D2564.
 - a. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - b. Solvent cement shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- C. Hubless, Cast-Iron Soil Pipe and Fittings
 1. Pipe and Fittings: ASTM A888 and CISPI 301All pipe and fittings shall be marked with manufacturer's name or Registered Trademark, country of origin, and date of manufacture. Pipe and fittings shall also bear the mark of the National Sanitation Foundation
 - a. Tensile Strength: 21,000
 - b. Each length of pipe and each fitting shall be plainly marked with size, country of origin, and name of manufacturer, or manufacturer's registered trademark by which the manufacturer can be readily identified after installation.
 2. Heavy-Duty, Hubless-Piping Couplings:
 - 1) ANACO-Husky.
 - 2) Charlotte Pipe and Foundry Company.
 - 3) Clamp-All Corp.
 - 4) Ideal Clamp Products
 - 5) MIFAB, Inc.
 - 6) Mission Rubber Company; a division of MCP Industries, Inc.
 - 7) Tyler Pipe.
 - 8) Dallas Specialty & Mfg. Co.
 - b. Standards: ASTM C1277 and ASTM C1540.
 - c. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.
- D. High Performance Coated Hub-and-Spigot, Cast-Iron Soil Pipe and Fittings
 1. Pipe and Fittings: ASTM A74, Service class.
 2. Gaskets: ASTM C564, rubber.
 3. Caulking Materials: ASTM B29, pure lead and oakum or hemp fiber.
 4. Tensile Strength: 21,000 psig minimum.
 5. All cast iron soil pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute (CISPI), and listed by NSF International.

6. Each length of pipe and each fitting shall be plainly marked with size, country of origin, and name of manufacturer, or manufacturer's registered trademark by which the manufacturer can be readily identified after installation.
 7. The inside of each pipe shall be reamed prior to coating to decrease the coefficient of friction.
 8. Pipe Coating: Chemically deposited zinc-phosphate pretreatment layer followed by an electrically deposited, high performance cathodic epoxy coating, and finally an electrically deposited, high performance anodic epoxy top coat. Coating thickness shall be 5 mils or greater on both the OD and ID.
 9. Fitting Coating: Chemically deposited zinc-phosphate pretreatment layer followed by an electrically deposited, high performance cathodic epoxy coating, and finally an epoxy acrylic powder top coat. Coating thickness shall be 5 mils or greater on both the OD and ID.
 10. Coating Performance: Pipe and Fitting Coatings must pass the following performance specifications per EN 877:
 - a. 350 hours of salt spray testing
 - b. Resistance to wastewater for 30 days at 73 deg F
 - c. Chemical resistance from pH 2 to pH 12 for 30 days at 73 deg F
 - d. Resistance to hot water for 24 hours at 203 deg F
- E. High Performance Coated Hubless, Cast-Iron Soil Pipe and Fittings
1. Pipe and Fittings: ASTM A888 or CISPI 301.
 2. Tensile Strength: 21,000 psig minimum.
 3. All cast iron soil pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute (CISPI), and listed by NSF International.
 4. Each length of pipe and each fitting shall be plainly marked with size, country of origin, and name of manufacturer, or manufacturer's registered trademark by which the manufacturer can be readily identified after installation.
 5. The inside of each pipe shall be reamed prior to coating to decrease the coefficient of friction.
 6. Pipe Coating: Chemically deposited zinc-phosphate pretreatment layer followed by an electrically deposited, high performance cathodic epoxy coating, and finally an electrically deposited, high performance anodic epoxy top coat. Coating thickness shall be 5 mils or greater on both the OD and ID.
 7. Fitting Coating: Chemically deposited zinc-phosphate pretreatment layer followed by an electrically deposited, high performance cathodic epoxy coating, and finally an epoxy acrylic powder top coat. Coating thickness shall be 5 mils or greater on both the OD and ID.
 8. Coating Performance: Pipe and Fitting Coatings must pass the following performance specifications per EN 877:
 - a. 350 hours of salt spray testing
 - b. Resistance to wastewater for 30 days at 73 deg F
 - c. Chemical resistance from pH 2 to pH 12 for 30 days at 73 deg F
 - d. Resistance to hot water for 24 hours at 203 deg F
 9. Heavy-Duty, Hubless-Piping Couplings:
 - 1) ANACO-Husky.
 - 2) Charlotte Pipe and Foundry Company.
 - 3) Mission Rubber Company, LLC; a division of MCP Industries.
 - 4) Mifab.
 - b. Standards: ASTM C1277 and ASTM C1540.
 - c. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.
- F. Transition Fittings

1. Transition Couplings:
 - a. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.
 - b. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
 - c. Unshielded, Nonpressure Transition Couplings:
 - (a) Fernco Inc.
 - (b) Froet Industries LLC.
 - (c) Mission Rubber Company; a division of MCP Industries, Inc.
 - 2) Standard: ASTM C1173.
 - 3) Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - (a) Froet Industries LLC.
 - 4) Sleeve Materials:
 - (a) For Cast-Iron Soil Pipes: ASTM C564, rubber.
 - (b) For Plastic Pipes: ASTM F477, elastomeric seal or ASTM D5926, PVC.
 - (c) For Dissimilar Pipes: ASTM D5926, PVC or other material compatible with pipe materials being joined.
 - d. Shielded, Nonpressure Transition Couplings:
 - (a) Fernco Inc.
 - (b) Froet Industries LLC.
 - (c) Mission Rubber Company; a division of MCP Industries, Inc.
 - 2) Standard: ASTM C1460.
 - 3) Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - 4) End Connections: Same size as and compatible with pipes to be joined.
 - e. Pressure Transition Couplings:
 - (a) Cascade Waterworks Mfg. Co.
 - (b) Dresser, Inc.
 - (c) EBAA Iron, Inc.
 - (d) Jay R. Smith Mfg. Co.
 - (e) JCM Industries, Inc.
 - (f) Romac Industries, Inc.
 - (g) Smith-Blair, Inc.; a Sensus company.
 - (h) The Ford Meter Box Company, Inc.
 - (i) Viking Johnson.
 - 2) Standard: AWWA C219.
 - 3) Description: Metal, sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.
 - 4) Center-Sleeve Material: Manufacturer's standard.
 - 5) Gasket Material: Natural or synthetic rubber.
 - 6) Metal Component Finish: Corrosion-resistant coating or material.
- G. Dielectric Fittings
 1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
 2. Dielectric Unions:
 - 1) Capitol Manufacturing Company.
 - 2) Hart Industries International, Inc.

- 3) Jomar International Ltd.
- 4) Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- 5) Wilkins; a Zurn company.
- 6) Central Plastics Company.
- 7) Matco-Norca, Inc.
- 8) McDonald, A. Y. Mfg. Co.
- b. Description:
 - 1) Standard: ASSE 1079.
 - 2) Pressure Rating: 250 psig (1725 kPa).
 - 3) End Connections: Solder-joint copper alloy and threaded ferrous.
3. Dielectric Flanges:
 - 1) Capitol Manufacturing Company.
 - 2) Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 3) Wilkins; a Zurn company.
 - 4) Central Plastics Company.
 - 5) Matco-Norca, Inc.- b. Description:
 - 1) Standard: ASSE 1079.
 - 2) Factory-fabricated, bolted, companion-flange assembly.
 - 3) Pressure Rating: 300 psig (2070 kPa).
 - 4) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
- 4. Dielectric-Flange Insulating Kits:
 - 1) Advance Products & Systems, Inc.
 - 2) Calpico, Inc.
 - 3) Central Plastics Company.
 - 4) Pipeline Seal and Insulator, Inc.- b. Description:
 - 1) Nonconducting materials for field assembly of companion flanges.
 - 2) Pressure Rating: 150 psig (1035 kPa).
 - 3) Gasket: Neoprene or phenolic.
 - 4) Bolt Sleeves: Phenolic or polyethylene.
 - 5) Washers: Phenolic with steel backing washers.
- 5. Dielectric Nipples:
 - 1) Elster Perfection.
 - 2) Grinnell Mechanical Products.
 - 3) Josam Company.
 - 4) Matco-Norca, Inc.
 - 5) Precision Plumbing Products, Inc.
 - 6) Victaulic Company.- b. Description:
 - 1) Standard: IAPMO PS 66.
 - 2) Electroplated steel nipple.
 - 3) Pressure Rating: 300 psig (2070 kPa) at 225 deg F (107 deg C).
 - 4) End Connections: Male threaded or grooved.
 - 5) Lining: Inert and noncorrosive, propylene.
 - 6) ANACO-Husky.
 - 7) Charlotte Pipe and Foundry Company.
 - 8) Mission Rubber Company, LLC; a division of MCP Industries.
 - 9) Mifab.
 - 10) ANACO-Husky, Series 4000.

- 11) Charlotte Pipe and Foundry Company.
- 12) Clamp-All Corp.
- 13) Ideal Clamp Products.
- 14) MIFAB, Inc.
- 15) Mission Rubber Company; a division of MCP Industries, Inc.
- 16) Tyler Pipe.
- 17) Dallas Specialty & Mfg. Co.
- 18) NewAge Casting
 - (a) Fernco Inc.
 - (b) Froet Industries LLC.
 - (c) Mission Rubber Company; a division of MCP Industries, Inc.
 - (d) Fernco Inc.
 - (e) Froet Industries LLC.
 - (f) Mission Rubber Company; a division of MCP Industries, Inc.
 - (g) Cascade Waterworks Mfg. Co.
 - (h) Dresser, Inc.
 - (i) EBAA Iron, Inc.
 - (j) Jay R. Smith Mfg. Co.
 - (k) JCM Industries, Inc.
 - (l) Romac Industries, Inc.
 - (m) Smith-Blair, Inc.; a Sensus company.
 - (n) The Ford Meter Box Company, Inc.
 - (o) Viking Johnson.
- 19) Capitol Manufacturing Company.
- 20) Hart Industries International, Inc.
- 21) Jomar International Ltd.
- 22) Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- 23) Wilkins; a Zurn company.
- 24) Central Plastics Company.
- 25) Matco-Norca, Inc.
- 26) McDonald, A. Y. Mfg. Co.
- 27) Capitol Manufacturing Company.
- 28) Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- 29) Wilkins; a Zurn company.
- 30) Central Plastics Company.
- 31) Matco-Norca, Inc.
- 32) Elster Perfection.
- 33) Grinnell Mechanical Products.
- 34) Josam Company.
- 35) Matco-Norca, Inc.
- 36) Precision Plumbing Products, Inc.
- 37) Victaulic Company.

2.04 ENCASEMENT FOR UNDERGROUND METAL PIPING

- A. Standard: ASTM A674 or AWWA C105/A21.5.
- B. Material: High-density, cross-laminated polyethylene film manufactured of virgin polyethylene material conforming to the requirements of ASTM D1248, and a minimum thickness of 0.004-inch.
- C. Form: Sheet or tube.
- D. Color: Black or natural.

PART 3 EXECUTION

3.01 INSTALLATION

A. Domestic Water Piping

1. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
2. Install piping as tight to underside of structure or as coordinated prior to installation with all other trades dictated by the general or prime contractor.
3. Unless approved by a registered and licensed structural Engineer building structure shall not be cut, drilled, notched, spliced or altered in any way.
4. Install underground copper tube and ductile-iron pipe in PE encasement according to ASTM A674 or AWWA C105/A21.5.
5. Copper Tubing
 - a. Install copper tubing under building slab according to CDA's "Copper Tube Handbook." All under slab piping shall be Annealed Type K copper with no soldered joints.
6. Ductile Iron Piping:
 - a. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.
7. Install shutoff valve immediately upstream of each dielectric fitting.
8. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements for pressure-reducing valves in Section 22 10 06 - Plumbing Piping Specialties.
9. Install domestic water piping level without pitch with 0.25 percent slope downward toward drain and plumb.
10. Rough-in domestic water piping for water-meter installation according to utility company's requirements.
11. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices in Section 20 05 48 - Vibration and Seismic Controls.
12. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
13. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
14. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
15. Install piping to permit valve servicing.
16. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.
17. Install piping free of sags and bends.
18. Install fittings for changes in direction and branch connections.
19. Install PEX piping with loop at each change of direction of more than 90 degrees.
20. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
21. Install pressure gages on suction and discharge piping for each plumbing pump and packaged booster pump. Comply with requirements for pressure gages in Section 20 05 19 - Meters and Gauges.
 - a. Install thermostats in hot-water circulation piping. Comply with requirements for thermostats in Section 22 11 23 - Domestic Water Pumps.
 - b. Install thermometers on inlet and outlet piping from each water heater. Comply with requirements for thermometers in Section 20 05 19 - Meters and Gauges.

- c. Install sleeves for piping penetrations of walls, ceilings, and floors.
 - d. Install sleeve seals for piping penetrations of concrete walls and slabs.
 - e. Install escutcheons for piping penetrations of walls, ceilings, and floors.
 - f. Install branch connections to mains using tee fittings in main pipe.
22. All non-metallic piping installed in an air supply or return plenum that shall be provided with a high temperature fiber blanket encapsulated in a fiberglass reinforced aluminized foil, with a 96 kg/m³ density and have a nominal thickness of 1/2 inch (13 mm). Fiber blanket shall have a continuous use limit in excess of 1,832 deg F. Flame spread index and smoke developed index shall be <25 / <50. Product shall be tested to ASTM E84, NFPA 262, and UL 1887.
23. Transition Fittings
- a. Install transition couplings at joints of dissimilar piping.
 - b. Transition Fittings in Underground Domestic Water Piping:
 - 1) Fittings for NPS 1-1/2 (DN 40) and Smaller: Fitting-type coupling.
 - 2) Fittings for NPS 2 (DN 50) and Larger: Sleeve-type coupling.
 - c. Transition Fittings in Aboveground Domestic Water Piping NPS 2 (DN 50) and Smaller: Plastic-to-metal transition fittings or unions.
24. Dielectric Fittings
- a. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
 - b. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric unions.
 - c. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Use dielectric flanges or nipples.
 - d. Dielectric Fittings for NPS 5 (DN 125) and Larger: Use dielectric flange kits.
25. Flexible Connectors
- a. Install flexible connectors in suction and discharge piping connections to each domestic water pump and in suction and discharge manifold connections to each domestic water booster pump.
 - b. Install bronze-hose flexible connectors in copper domestic water tubing.
 - c. Install stainless-steel-hose flexible connectors in steel domestic water piping.
26. Hangers and Supports
- a. Comply with requirements for seismic-restraint devices in Section 20 05 48 - Vibration and Seismic Controls.
 - b. Comply with requirements for pipe hanger, support products, and installation in Section 20 05 29 - Hangers and Supports.
 - c. Support vertical piping and tubing at base and at each floor, or as required by prevailing code if such code is more stringent.
 - d. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch (10 mm).
 - e. Install hangers for copper tubing and piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
 - f. Install vinyl-coated hangers for CPVC piping, with maximum horizontal spacing and minimum rod diameters, to comply with Project Location's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
 - g. Install vinyl-coated hangers for PEX tubing, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
 - h. Support horizontal piping within 12 inches (300 mm) of each fitting.
 - i. Support vertical runs of copper tubing and piping to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

- j. Support vertical runs of CPVC piping to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
 - k. Support vertical runs of PEX tubing to comply with Project Location's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
 - l. Support piping and tubing not listed in this article according to MSS SP-58 and Project Location's written instructions.
27. Escutcheons
- a. Install escutcheons for penetrations of walls, ceilings, and floors.
 - b. Comply with the requirements of Section 20 05 00 - Common Mechanical Work Results.
 - c. Escutcheons for New Piping:
 - 1) Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
 - 2) Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
 - 3) Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
 - 4) Bare Piping in Unfinished Service Spaces: One piece, cast brass with polished chrome-plated finish.
 - 5) Bare Piping in Equipment Rooms: One piece, cast brass.
 - 6) Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting floor plate.
 - d. Escutcheons for Existing Piping:
 - 1) Chrome-Plated Piping: Split casting, cast brass with chrome-plated finish.
 - 2) Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split casting, cast brass with chrome-plated finish.
 - 3) Bare Piping at Ceiling Penetrations in Finished Spaces: Split casting, cast brass with chrome-plated finish.
 - 4) Bare Piping in Unfinished Service Spaces: Split casting, cast brass with polished chrome-plated finish.
 - 5) Bare Piping in Equipment Rooms: Split casting, cast brass.
 - 6) Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting floor plate.
28. Joint Construction
- a. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
 - b. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
 - c. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1) Apply appropriate tape or thread compound to external pipe threads.
 - 2) Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
 - d. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Brazed Joints" chapter.
 - e. Soldered Joints for Copper Tubing: Apply ASTM B813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B828 or CDA's "Copper Tube Handbook."
 - f. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer. Leave insertion marks on pipe after assembly.

- g. Extruded-Tee Connections: Form tee in copper tube according to ASTM F2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.
 - h. Joint Construction for Grooved-End Copper Tubing: Make joints according to AWWA C606. Roll groove ends of tubes. Lubricate and install gasket over ends of tubes or tube and fitting. Install coupling housing sections over gasket with keys seated in tubing grooves. Install and tighten housing bolts.
 - i. Joint Construction for Grooved-End, Ductile-Iron Piping: Make joints according to AWWA C606. Cut round-bottom grooves in ends of pipe at gasket-seat dimension required for specified (flexible or rigid) joint. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.
 - j. Joint Construction for Grooved-End Stainless and Galvanized Steel Piping: Make joints according to AWWA C606. Roll groove ends of pipe as specified. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.
 - k. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.
 - l. Joint Construction for Solvent-Cemented Plastic Piping: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1) Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements. Apply primer.
 - 2) CPVC Piping: Join according to ASTM D2846/D2846M Appendix.
 - m. Joint Construction for Grooved-End CPVC Piping: Make joints according to PGS-300. Cut groove ends of pipe as specified. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.
 - n. Joint Construction for polypropylene and PVDF Piping: Per Project Location's recommendations.
 - o. Joints for PEX Tubing: Join according to ASTM F1807 for metal insert and copper crimp ring fittings and ASTM F1960 for cold expansion fittings and reinforcing rings.
 - p. Joints for PEX Tubing: Join according to ASSE 1061 for push-fit fittings.
 - q. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.
29. Valves
- a. General-Duty Valves: Comply with requirements in Section 22 05 23 - General Duty Valves for Plumbing Piping for valve installations.
 - b. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures or groups of plumbing fixtures within the same room. Use ball or gate valves for piping NPS 2 (DN 50) and smaller. Use gate valves for piping NPS 2-1/2 (DN 65) and larger.
 - 1) Install shutoff valve on each water supply serving each patient room per IDPH requirements.
 - c. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping. Drain valves are specified in Section 22 10 06 - Plumbing Piping Specialties.
 - 1) Hose-End Drain Valves: At low points in water mains, risers, and branches.
 - 2) Stop-and-Waste Drain Valves: Instead of hose-end drain valves where indicated.
 - d. Install balancing valve in each hot-water circulation return branch and discharge side of each pump and circulator. Set balancing valves partly open to restrict but not stop

flow. Use ball valves for piping NPS 2 (DN 50) and smaller and butterfly valves for piping NPS 2-1/2 (DN 65) and larger. Comply with requirements in Section 22 10 06 - Plumbing Piping Specialties for balancing valves. Balancing valve assembly to include shutoff valve, check valve and balancing valve.

- e. Install calibrated balancing valves in each hot-water circulation return branch and discharge side of each pump and circulator. Set calibrated balancing valves partly open to restrict but not stop flow. Comply with requirements in Section 22 10 06 - Plumbing Piping Specialties for calibrated balancing valves. Balancing valve assembly to include shutoff valve, check valve and balancing valve.

B. Sanitary Waste and Vent Piping

1. Unless approved by a registered and licensed structural Engineer, building structure shall not be cut, drilled, notched, spliced or altered in any way.
2. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.
 - a. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.
 - b. Install piping as indicated unless deviations to layout are approved on coordination drawings.
3. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
4. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
5. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
6. Install piping to permit valve servicing.
7. Install piping at indicated slopes.
8. Install piping free of sags and bends.
9. Install fittings for changes in direction and branch connections.
10. Install wall-penetration fitting at each service pipe penetration through foundation wall. Make installation watertight.
11. Install piping and support devices to allow application of insulation.
12. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Section 20 05 48 - Vibration and Seismic Controls for piping and equipment.
13. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends.
 - a. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical.
 - b. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe.
 - 1) Straight tees, elbows, and crosses may be used on vent lines.
 - c. Do not change direction of flow more than 90 degrees.
 - d. Use proper size of standard increasers and reducers if pipes of different sizes are connected.
 - 1) Reducing size of waste piping in direction of flow is prohibited.
14. Lay buried building waste piping beginning at low point of each system.
 - a. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
 - b. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
 - c. Maintain swab in piping and pull past each joint as completed.
15. Install soil and waste drainage and vent piping at the minimum slopes required by code.

16. Install soil and waste and vent piping at the following minimum slopes unless otherwise indicated:

- a. Slope of Horizontal Drainage Piping:

Pipe Size	Minimum Slope
NPS 2-1/2 (DN 65) or Less	1/4 inch per foot (2%)
NPS 3 (DN 80) to NPS 6 (DN 150)	1/8 inch per foot (1%)
NPS 8 (DN 200) or Larger	1/16 inch per foot (0.5%)

- b. Slope of Horizontal Drainage Piping:

Pipe Size	Minimum Slope
NPS 3 (DN 80) or Less	1/4 inch per foot (2%)
NPS 8 (DN 200) or Larger	1/8 inch per foot (1%)

- c. Slope of Horizontal Grease Waste Piping:

Pipe Size	Minimum Slope
NPS 2-1/2 (DN 65) or Less	1/4 inch per foot (2%)
NPS 3 (DN 80) to NPS 6 (DN 150)	1/8 inch per foot (1%)
NPS 8 (DN 200) or Larger	1/16 inch per foot (0.5%)

- d. Slope of Horizontal Grease Waste Piping:

Pipe Size	Minimum Slope
ALL	1/4 inch per foot (2%)

- e. Slope of Horizontal Grease Waste Piping:

Pipe Size	Minimum Slope
NPS 3 (DN 80) or Less	1/4 inch per foot (2%)
NPS 4 (DN 100) or Larger	1/8 inch per foot (1%)

- f. Vent Piping: 1/8 inch per foot (1%) down toward vertical fixture vent or toward vent stack.

17. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
- a. Install encasement on underground piping according to ASTM A674 or AWWA C105/A21.5
18. Install steel piping according to applicable plumbing code.
19. Install stainless-steel piping according to ASME A112.3.1 and applicable plumbing code.
20. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."
21. Install aboveground ABS piping according to ASTM D2661 .
22. Install aboveground PVC piping according to ASTM D2665 .
23. All non-metallic piping installed in an air supply or return plenum that shall be provided with a high temperature fiber blanket encapsulated in a fiberglass reinforced aluminized foil, with a 96 kg/m3 density and have a nominal thickness of 1/2 inch (13 mm). Fiber blanket shall have a continuous use limit in excess of 1,832 deg F. Flame spread index and smoke developed index shall be <25 / <50. Product shall be tested to ASTM E84, NFPA 262, and UL 1887.
24. Install underground PVC piping according to ASTM D2321.
25. Install engineered soil and waste drainage and vent piping systems as follows:
- a. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.
- b. Hubless, Single-Stack Drainage System: Comply with ASME B16.45 and hubless, single-stack aerator fitting manufacturer's written installation instructions.
- c. Reduced-Size Venting: Comply with standards of authorities having jurisdiction.
26. Install underground, ductile-iron, force-main piping according to AWWA C600 .

- a. Install buried piping inside building between wall and floor penetrations and connection to sanitary sewer piping outside building with restrained joints.
- b. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.
- c. Install encasement on piping according to ASTM A674 or AWWA C105/A21.5 .
- 27. Install underground, copper, force-main tubing according to CDA's "Copper Tube Handbook."
- a. Install encasement on piping according to ASTM A674 or AWWA C105/A21.5 .
- 28. Install force mains at elevations indicated.
- 29. Plumbing Specialties:
 - a. Install backwater valves in sanitary waste gravity-flow piping. Comply with requirements for backwater valves specified in Section 22 10 06 - Plumbing Piping Specialties.
 - b. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary drainage gravity-flow piping.
 - c. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping. Comply with requirements for cleanouts specified in Section 22 10 06 - Plumbing Piping Specialties.
 - d. Install drains in sanitary drainage gravity-flow piping. Comply with requirements for drains specified in Section 22 10 06 - Plumbing Piping Specialties.
- 30. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- 31. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 20 05 00 - Common Mechanical Work Results.
- 32. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 20 05 00 - Common Mechanical Work Results.
- 33. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 20 05 00 - Common Mechanical Work Results.
- 34. Every vent stack shall connect to the base of the drainage stack at or below the lowest horizontal branch.
- 35. Horizontal offsets of drainage stacks shall be vented where 5 or more branch internals are located above the offset. The upper and lower sections of the drainage stack shall be vented and sized per code.
- 36. Branch vents shall rise 6 inches (150 mm) above the flood level rim of the fixture being vented.
- 37. All vent terminations shall be a minimum of 12 inches (300 mm) above the roof, or 7 feet above any occupied roof area.
- 38. Vent through roofs shall be a minimum of 4 inches (100 mm) for frost protection.
- 39. The maximum distance between the vent and trap shall be 5 feet.
- 40. Soil and waste stacks in buildings having more than 10 branch intervals shall be provided with a full size relief vent at each tenth interval installed, beginning with the top floor.
- 41. All indirect waste shall be a minimum of 1 inch (25 mm) unless otherwise noted on drawing.
- 42. All sanitary offsets shall be vented per local authority.
- 43. Hangers and Supports
 - a. Comply with requirements for seismic-restraint devices specified in Section 20 05 48 - Vibration and Seismic Controls.
 - b. Comply with requirements for pipe hanger and support devices and installation specified in Section 20 05 29 - Hangers and Supports.

- 1) Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
- 2) Install stainless-steel pipe hangers for horizontal piping in corrosive environments.
- 3) Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
- 4) Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
- 5) Vertical Piping: MSS Type 8 or Type 42, clamps.
- 6) Install individual, straight, horizontal piping runs:
 - (a) 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
 - (b) Longer Than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.
 - (c) Longer Than 100 Feet (30 m) if Indicated: MSS Type 49, spring cushion rolls.
 - (1) NPS 4 and NPS 5 (DN 100 and DN 125): 12 feet (3.7 m) with 5/8-inch (16-mm) rod.
- 7) Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
- 8) Base of Vertical Piping: MSS Type 52, spring hanger
- c. Support horizontal piping and tubing within 12 inches (300 mm) of each fitting, valve and coupling.
- d. Support vertical piping and tubing at base and at each floor.
- e. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch (10-mm) minimum rods.
- f. Install hangers for cast-iron soil piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent (1500 mm).
- g. Support vertical runs of cast-iron soil piping to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- h. Install hangers for PVC piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- i. Support vertical runs of PVC piping to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- j. Support piping and tubing not listed above according to MSS SP-58 and manufacturer's written instructions.
- k. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.
44. Valves
 - a. General valve installation requirements are specified in Section 22 05 23 - General Duty Valves for Plumbing Piping.
 - b. Shutoff Valves:
 - 1) Install shutoff valve on each sewage pump discharge.
 - 2) Install gate or full-port ball valve for piping NPS 2 (DN 50) and smaller.
 - 3) Install gate valve for piping NPS 2-1/2 (DN 65) and larger.
 - c. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.
 - d. Backwater Valves: Install backwater valves in piping subject to backflow.
 - 1) Horizontal Piping: Horizontal backwater valves.
 - 2) Floor Drains: Drain outlet backwater valves unless drain has integral backwater valve.

- 3) Comply with requirements for backwater valve specified in Section 22 10 06 - Plumbing Piping Specialties.
45. Suds Pressure Zones
 - a. Drainage stacks receiving waste from kitchen sinks, automatic dishwashers, laundry trays, laundry washing machines and similar fixtures in which sudsy detergents are normal used shall have the drainage and vent piping so arranged that suds pressures will not affect fixtures in the lower portion of the drainage system. Suds zones shall be considered to exist at any offset of 60 degrees to 90 degrees or at the base of any drainage stack.
 - 1) When the drainage portion of a stack exceed 16 feet in height above a 45 degree to 90 degree offset or house drain, it shall have its lower portion consisting of 30% of its height from such offset free of any fixture drain or branch. Such suds pressure zone of the drainage stack need not exceed 24 feet in height.
 - 2) In the offset of 60 degrees to 90 degrees or a house drain, when the drainage portion of a stack exceed 16 feet in height, a zone in the horizontal piping consisting of 30% upstream of the drainage stack connection shall be free of any drainage openings. Such suds pressure zone of the offset or house drain need not exceed 24 feet in height.
 - 3) In the offset of 60 degrees to 90 degrees or a house drain, when the drainage portion of a stack exceed 16 feet in height, a zone in the horizontal piping consisting of 15% downstream of the drainage stack connection shall be free of any drainage openings. Such suds pressure zone of the offset or house drain need not exceed 12 feet in height.
 - 4) Where a vertical offset occurs in a soil or waste stack below the lowest horizontal branch, change in diameter of the stack because of the offset shall not be required. If a horizontal offset occurs in a soil or waste stack below the lowest horizontal branch, the required diameter of the offset and the stack below it shall be determined as for a building drain.
46. Air Chambers
 - a. Install air chambers at the upper terminals of all up-feed riser pipes and in branch distributing pipes contiguous to, and directly above, the connection of such branch distributing pipes to the plumbing fixture or other water-supplied appliance. Such air chambers shall be installed in a direct line with the flow of water through such pipes and shall be of sufficient capacity to provide an air cushion which will absorb shock, stress, or strain or eliminate all excess noises which may be caused by the operation of any valves, faucets, bibbs, or cocks in the water supply system.
 - 1) All air chambers shall be the same size of the pipe which it serves and to which it is connected and shall be not less than 2 feet (610 mm) in length. The air chamber on each water supply branch connection to a plumbing fixture shall be not less than 12 inches (300 mm) long. Flush valve air chambers shall be of pipe size by 18 inches (450 mm) long.

3.02 CONNECTIONS

- A. Domestic Water Piping
 1. Drawings indicate general arrangement of piping, fittings, and specialties.
 2. When installing piping adjacent to equipment and machines, allow space for service and maintenance.
 3. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.
 4. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
 - a. Domestic Water Booster Pumps: Cold-water suction and discharge piping.

- b. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
 - c. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
 - d. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 (DN 65) and larger.
- B. Sanitary Waste and Vent Piping
- 1. Drawings indicate general arrangement of piping, fittings, and specialties.
 - 2. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.
 - 3. Connect drainage and vent piping to the following:
 - 4. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
 - a. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
 - b. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
 - c. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
 - d. Install horizontal backwater valves with cleanout cover flush with floor.
 - e. Comply with requirements for backwater valves, cleanouts, and drains specified in Section 22 10 06 - Plumbing Piping Specialties.
 - f. Equipment: Connect drainage piping as indicated. Provide shutoff valve if indicated and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 (DN 65) and larger.
 - 5. Connect force-main piping to the following:
 - a. Sanitary Sewer: To exterior force main.
 - b. Sewage Pump: To sewage pump discharge.
 - 6. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
 - 7. Make connections according to the following unless otherwise indicated:
 - a. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
 - b. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.03 FIELD TESTING

- A. Domestic Water Piping
- 1. Perform the following tests and inspections:
 - a. Piping Inspections:
 - 1) Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
 - 2) During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
 - (a) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
 - (b) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.
 - 3) Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.

- 4) Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- b. Piping Tests:
 - 1) Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
 - 2) Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
 - 3) Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - 4) Cap and subject piping to static water pressure of 50 psig (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
 - 5) Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
 - 6) Prepare reports for tests and for corrective action required.
2. Copper and Stainless Steel Pipe Press Fittings
 - a. Copper and Stainless Steel pipe joined with pressure fit fittings shall be in accordance with the manufacturer's installation instructions. Obtain any required Viega or NIBCO certified training to successfully meet these requirements at no extra cost to the project. The tubing shall be fully inserted into the fitting and the tubing marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark on the tubing to ensure the tubing is fully engaged (inserted) into the fitting. The joints shall be pressed using the tool approved by the manufacturer.
 - b. Contractor shall have a pipe fitting procedure in place to distinctly identify each individual's pipe connection. Each individual pipe fitter must identify their pipe connection with an approved identification marking (ie. colored electrical tape or initialed pipe connections, etc.)
3. Grooved Mechanical Joints:
 - a. Correct installation of couplings shall be visually verifiable. Should couplings be used which have a torque requirement, the contractor shall create a log of the measured torque at every mechanical joint.
 - b. The grooved coupling manufacturer's factory trained representative shall provide on-site training for contractor's field personnel in the use of grooving tools, application of groove, and installation of grooved joint products.
 - c. Extended piping system warranty:
 - 1) A manufacturer's factory trained inspector shall visit the job site and review an agreed upon percentage of the installed mechanical joints. This shall be at the expense of the installing contractor. The installing Contractor shall correct any identified deficiencies.
 - 2) Grooved product that has been examined and has not met the visual inspection criteria for proper installation must be corrected and re-examined by manufacturer's representative prior to the completion of the project. Any grooved product that has not been corrected or was not examined will not be considered as part of the successful completion of inspection.
4. Domestic water piping will be considered defective if it does not pass tests and inspections.
5. Prepare test and inspection reports.
 - a. Perform final testing in presence of owner or owner's representative
 - b. Prepare reports for tests and for corrective action required.

- c. Provide owner documentation indicating successful testing is completed.
- B. Sanitary Waste and Vent Piping
 - 1. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
 - a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - b. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
 - 2. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
 - 3. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
 - 4. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 - a. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 - b. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - c. Roughing-in Plumbing Test Procedure: Test drainage and vent piping except outside leaders on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water (30 kPa). From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
 - d. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg (250 Pa). Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
 - e. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 - f. Perform final testing in presence of owner or owner's representative
 - g. Prepare reports for tests and for corrective action required.
 - h. Provide owner documentation indicating successful testing is completed.
 - 5. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 - a. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - b. Cap and subject piping to static-water pressure of 50 psig (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
 - c. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 - d. Perform final testing in presence of owner or owner's representative
 - e. Prepare reports for tests and for corrective action required.
 - f. Provide owner documentation indicating successful testing is completed.

3.04 IDENTIFICATION

- A. Domestic Water Piping
 - 1. Identify system components. Comply with requirements for identification materials and installation in Section 20 05 53 - Mechanical Identification.
 - 2. Label pressure piping with system operating pressure.
- B. Sanitary Waste and Vent Piping
 - 1. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Section 20 05 53 - Mechanical Identification.

3.05 ADJUSTING

- A. Domestic Water Piping
 - 1. Perform the following adjustments before operation:
 - a. Close drain valves, hydrants, and hose bibbs.
 - b. Open shutoff valves to fully open position.
 - c. Open throttling valves to proper setting.
 - d. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
 - 1) Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
 - 2) Adjust calibrated balancing valves to flows indicated.
 - e. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
 - f. Remove and clean strainer screens. Close drain valves and replace drain plugs.
 - g. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
 - h. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.06 CLEANING

- A. Domestic Water Piping
 - 1. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.
 - 2. Clean and disinfect potable domestic water piping as follows:
 - a. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
 - b. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
 - 1) Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - 2) Fill and isolate system according to either of the following:
 - (a) Fill system or part thereof with water/chlorine solution with at least 50 ppm (50 mg/L) of chlorine. Isolate with valves and allow to stand for 24 hours.
 - (b) Fill system or part thereof with water/chlorine solution with at least 200 ppm (200 mg/L) of chlorine. Isolate and allow to stand for three hours.
 - c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
 - 1) Submit water samples in sterile bottles to authorities having jurisdiction.
 - 2) Repeat procedures if biological examination shows contamination.
 - 3. Clean non-potable domestic water piping as follows:
 - a. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
 - b. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:

- 1) Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - 2) Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.
 - 3) Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.
- B. Sanitary Waste and Vent Piping
1. Clean interior of piping. Remove dirt and debris as work progresses.
 2. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
 3. Place plugs in ends of uncompleted piping at end of day and when work stops.
 4. Exposed PVC and ABS Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.
 5. Repair damage to adjacent materials caused by waste and vent piping installation.

3.07 EARTHWORK

- A. Comply with requirements for excavating, trenching, and backfilling specified in Division 31 Section "Earth Moving." At minimum, backfill shall be free from discarded construction material and debris. Loose earth, free from rocks, broken concrete, frozen chunks and other rubble, shall be placed in the trench in NPS 6 (150 mm) layers and tamped in place until the crown of the pipe is covered by 12 inches (305 mm) of tamped earth. The backfill under and beside the pipe shall be compacted for pipe support. Backfill shall be brought up evenly on both sides of the pipe so that the pipe remains aligned.
- B. In instances where the manufacturer's installation instructions are more restrictive than those prescribed by the paragraph above, the material shall be installed in accordance with the more restrictive requirement.
- C. Unless approved by a registered and licensed structural Engineer, trenching installed parallel to footings shall not extend into the bearing plane of a footing or wall. The upper boundary of the bearing plane is a line that extends downward, at an angle of 45 degrees (0.79 rad) from horizontal, from the outside bottom of the footing or wall.

3.08 PIPING SCHEDULE

- A. Domestic Water Piping
1. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
 2. Flanges and unions may be used for aboveground piping joints only unless otherwise indicated.
 3. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.
 4. Only, and must be formed and pressure tested off-site prior to project installation.
 5. Water service entry, domestic water, building-service piping, NPS 3 (DN 80) and smaller, shall be the following:
 - a. Annealed copper tube, ASTM B88, Type K (ASTM B88M, Type A); wrought-copper, solder-joint fittings; and brazed joints.
 6. Water service entry, domestic water, building-service piping, NPS 4 (DN 100 to DN 200) and larger, shall be one of the following:
 - a. Annealed copper tube, ASTM B88, Type K (ASTM B88M, Type A); wrought-copper, solder-joint fittings; and brazed joints.
 - b. Push-on-joint, ductile-iron pipe; standard-pattern, push-on-joint fittings; and gasketed joints.
 7. Under-building-slab, combined domestic water, building-service, and fire-service-main piping, NPS 6 to NPS 12 (DN 150 to DN 300), shall be the following:

- a. Push-on-joint, ductile-iron pipe; standard-pattern, push-on-joint fittings; and gasketed joints.
- 8. Under-building-slab, domestic water piping, NPS 2 (DN 50) and smaller, shall be the following:
 - a. Soft copper tube, ASTM B88, Type K (ASTM B88M, Type B); rolled changes in direction, no underground joints.
- 9. Aboveground domestic water piping, NPS 2 (DN 50) and smaller, shall be one of the following:
 - a. Hard copper tube, ASTM B88, Type L (ASTM B88M, Type B); cast- or wrought-copper, solder-joint fittings; and brazed or soldered joints.
 - b. Hard copper tube, ASTM B88, Type L (ASTM B88M, Type B); copper pressure-seal-joint fittings; and pressure-sealed joints based upon satisfactory compliance with above sections governing the use if Viega Pro-Press as an alternate.
 - c. CPVC, Schedule 40; socket fittings; and solvent-cemented joints for softened or process water applications only, refer to drawings for application. CPVC shall NOT be used for standard domestic water applications.
 - d. PEX tube, NPS 1 (DN 25) and smaller.
 - 1) Fittings for PEX tube:
 - (a) ASTM F1807, metal insert and copper crimp rings.
 - (b) ASTM F1960, cold expansion fittings and reinforcing rings.
 - (c) ASSE 1061, push-fit fittings.
 - e. PEX-AL-PEX tube, NPS 1 (DN 25) and smaller; fittings for PEX-AL-PEX tube; and crimped joints.
 - f. PVDF pipe and fittings, with heat fusion joints.
- 10. Aboveground domestic water piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100) , shall be one of the following:
 - a. Hard copper tube, ASTM B88, Type L (ASTM B88M, Type B); cast- or wrought-copper, solder-joint fittings; and brazed or soldered joints.
 - b. Hard copper tube, ASTM B88, Type L (ASTM B88M, Type B); copper pressure-seal-joint fittings; and pressure-sealed joints based upon satisfactory compliance with above sections governing the use if Viega Pro-Press as an alternate.
 - c. Hard copper tube, ASTM B88, Type L (ASTM B88M, Type B); grooved-joint, copper-tube appurtenances; and grooved joints.
 - d. Stainless steel, Schedule 40 pipe; grooved-joint fittings, and grooved joints.
 - e. Stainless steel, Schedule 40 pipe, stainless steel pressure-seal-joint fittings; and pressure-sealed joints based upon satisfactory compliance with above sections governing the use if Viega Pro-Press as an alternate
 - f. CPVC, Schedule 40; socket fittings; and solvent-cemented joints for softened or process water applications only, refer to drawings for application. CPVC shall NOT be used for standard domestic water applications.
 - g. PVDF pipe and fittings, with heat fusion joints.
- 11. Aboveground domestic water piping, NPS 5 to NPS 8 (DN 125 to DN 200), shall be one of the following:
 - a. Hard copper tube, ASTM B88, Type L (ASTM B88M, Type B); grooved-joint, copper-tube appurtenances; and grooved joints.
 - b. Stainless-steel pipe and fittings, stainless steel pipe appurtenances, and grooved joints.
 - c. Galvanized-steel pipe and nipples; galvanized, gray-iron threaded fittings; and threaded joints.
 - d. Galvanized-steel pipe; grooved-joint, galvanized-steel-pipe appurtenances; and grooved joints.
- 12. Aboveground, combined domestic water-service and fire-service-main piping, NPS 6 to NPS 12 (DN 150 to DN 300), shall be one of the following:

- a. Plain-end, ductile-iron pipe; grooved-joint, ductile-iron-pipe appurtenances; and grooved joints.
 - b. Mechanical joint, gasket and follower ring, bell end ductile-iron pipe; standard-pattern, push-on-joint fittings; and gasketed joints.
 - c. Stainless-steel pipe and fittings, stainless steel pipe appurtenances, and grooved joints.
 - d. Galvanized-steel pipe and nipples; galvanized, gray-iron threaded fittings; and threaded joints.
 - e. Galvanized-steel pipe; grooved-joint, galvanized-steel-pipe appurtenances; and grooved joints.
- B. Sanitary Waste and Vent Piping
1. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
- C. Underground, soil, waste, and vent piping NPS 4 (DN 100) and smaller shall be any of the following:
1. Extra Heavy class, cast-iron soil piping; gaskets; and gasketed joints.
 2. Hubless, cast-iron soil pipe and fittings; CISPI cast-iron hubless-piping couplings; and coupled joints.
 - a. Stainless-steel pipe and fittings, gaskets, and gasketed joints.
 - b. Solid wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 - c. Dissimilar Pipe-Material Couplings: Transition couplings and/or dielectric fittings as scheduled above.
 3. Underground, soil and waste piping NPS 5 (DN 125) and larger shall be any of the following:
 - a. Extra Heavy class, cast-iron soil piping; gaskets; and gasketed joints.
 - b. Hubless, cast-iron soil pipe and fittings; CISPI cast-iron hubless-piping couplings; coupled joints.
 - c. Solid-wall PVC pipe; PVC socket fittings; and solvent-cemented joints.
 - d. Dissimilar Pipe-Material Couplings: Transition couplings and/or dielectric fittings as scheduled above.
 4. Aboveground, soil and waste piping NPS 4 (DN 100) and smaller shall be any of the following:
 - a. Service class, hub and spigot cast-iron soil pipe and fittings; caulked lead and oakum joints.
 - b. Hubless, cast-iron soil pipe and fittings and hubless, single-stack aerator fittings; CISPI hubless-piping couplings; and coupled joints.
 - c. Galvanized-steel pipe, drainage fittings, and threaded joints.
 - d. Stainless-steel pipe and fittings, sealing rings, and gasketed joints.
 - e. Copper Type M tube, copper drainage fittings, and soldered joints.
 - f. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 - g. Dissimilar Pipe-Material Couplings: Transition couplings and/or dielectric fittings as scheduled above.
 5. Aboveground, soil and waste piping NPS 5 (DN 125) and larger shall be any of the following:
 - a. Service class, hub and spigot cast-iron soil pipe and fittings; caulked lead and oakum joints.
 - b. Hubless, cast-iron soil pipe and fittings; CISPI cast-iron hubless-piping couplings; and coupled joints.
 - c. Galvanized-steel pipe, drainage fittings, and threaded joints.
 - d. Stainless-steel pipe and fittings, sealing rings, and gasketed joints.
 - e. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

- f. Dissimilar Pipe-Material Couplings: Transition couplings and/or dielectric fittings as scheduled above.
- 6. Underground, Grease and Oil add application used on plans here waste piping shall be any of the following ALL SIZES:
 - a. Service class, high performance coated hub and spigot cast-iron soil piping; gaskets; and gasketed joints.
 - b. Service class, hubless, high performance coated cast-iron soil pipe and fittings; heavy-duty cast-iron hubless-piping couplings; coupled joints.
 - c. Dissimilar Pipe-Material Couplings: Transition couplings and/or dielectric fittings as scheduled above.
- 7. Above ground, Grease and Oil add application used on plans here waste piping shall be any of the following ALL SIZES:
 - a. Service class, high performance coated hub and spigot cast-iron soil piping; gaskets; and gasketed joints.
 - b. Service class, hubless, high performance coated cast-iron soil pipe and fittings; heavy-duty cast-iron hubless-piping couplings; coupled joints.
 - c. Dissimilar Pipe-Material Couplings: Transition couplings and/or dielectric fittings as scheduled above
- 8. Above ground, vent piping NPS 4 (DN 100) and smaller shall be any of the following:
 - a. Hard copper tube, Type M (Type C); copper pressure fittings; and soldered joints (2-1/2 inch (63 mm) or less only).
 - b. Service class, hub and spigot cast-iron soil pipe and fittings; caulked lead and oakum joints.
 - c. Hubless, cast-iron soil pipe and fittings; CISPI cast-iron hubless-piping couplings; and coupled joints.
 - d. Galvanized-steel pipe, drainage fittings, and threaded joints.
 - e. Stainless-steel pipe and fittings gaskets, and gasketed joints.
 - f. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 - g. Dissimilar Pipe-Material Couplings: Transition couplings and/or dielectric fittings as scheduled above.
- 9. Above ground, vent piping NPS 5 (DN 125) and larger Insert pipe size range shall be any of the following:
 - a. Service class, hub and spigot cast-iron soil pipe and fittings; caulked lead and oakum joints.
 - b. Hubless, cast-iron soil pipe and fittings; CISPI cast-iron hubless-piping couplings; and coupled joints.
 - c. Galvanized-steel pipe, drainage fittings, and threaded joints.
 - d. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 - e. Dissimilar Pipe-Material Couplings: Transition couplings and/or dielectric fittings as scheduled above.
- 10. Underground sanitary-sewage force mains NPS 4 (DN 100) and smaller shall be any of the following:
 - a. Hard copper tube, Type L (Type B); wrought-copper pressure fittings; and soldered joints.
 - b. Ductile-iron, mechanical-joint piping and mechanical joints.
 - c. Ductile-iron, push-on-joint piping and push-on joints.
 - d. Ductile-iron, grooved-joint piping and grooved joints.
 - e. Fitting-type transition coupling for piping smaller than NPS 1-1/2 (DN 40) and pressure transition coupling for NPS 1-1/2 (DN 40) and larger if dissimilar pipe materials.
- 11. Underground sanitary-sewage force mains NPS 5 (DN 125) and larger shall be any of the following:

- a. Hard copper tube, Type L (Type B); wrought-copper pressure fittings; and soldered joints.
 - b. Ductile-iron, mechanical-joint piping and mechanical joints.
 - c. Ductile-iron, push-on-joint piping and push-on joints.
 - d. Ductile-iron, grooved-joint piping and grooved joints.
 - e. Pressure transition couplings if dissimilar pipe materials.
12. Above ground sanitary-sewage force mains NPS 1-1/2 and NPS 2 (DN 40 and DN 50) shall be any of the following:
 - a. Hard copper tube, Type L (Type B); copper pressure fittings; and soldered joints.
 - b. Galvanized-steel pipe, pressure fittings, and threaded joints.
13. Aboveground sanitary-sewage force mains NPS 2-1/2 to NPS 6 (DN 65 to DN 150) shall be any of the following:
 - a. Hard copper tube, Type L (Type B); copper pressure fittings; and soldered joints.
 - b. Galvanized-steel pipe, pressure fittings, and threaded joints.
 - c. Grooved-end, galvanized-steel pipe; grooved-joint, galvanized-steel-pipe appurtenances; and grooved joints.

3.09 VALVE SCHEDULE

- A. Domestic Water Piping
 1. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
 - a. Shutoff Duty: Use ball or gate valves for piping NPS 2 (DN 50) and smaller. Use butterfly, ball, or gate valves with flanged ends for piping NPS 2-1/2 (DN 65) and larger.
 - b. Throttling Duty: Use ball or globe valves for piping NPS 2 (DN 50) and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 (DN 65) and larger.
 - c. Hot-Water Circulation Piping, Balancing Duty: Calibrated balancing valves.
 - d. Drain Duty: Hose-end drain valves with cap and chain.
 2. Use check valves to maintain correct direction of domestic water flow to and from equipment.
 3. Provide check valve on branch piping downstream of hot water circulation balancing valve.
 4. Iron grooved-end valves may be used with grooved-end piping.

END OF SECTION

**SECTION 22 10 06
PLUMBING PIPING SPECIALTIES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Domestic Water Piping Specialties
 - 1. Vacuum Breakers.
 - 2. Backflow Preventers.
 - 3. Automatic water shutoff valve systems.
 - 4. Mechanical Balancing Valves.
 - 5. Digital balancing and flushing valves.
 - 6. Mechanical, temperature-actuated balancing valves.
 - 7. Flow Splitter Valves.
 - 8. Temperature-Actuated, Water Mixing Valves.
 - 9. Strainers.
 - 10. Hose Bibbs.
 - 11. Wall Hydrants.
 - 12. Water-Hammer Arresters.
 - 13. Air Vents.
 - 14. Pressure Trap-Seal Primer Device.
 - 15. Electronic Trap-Seal Primer Systems.
- B. Sanitary Waste Piping Specialties
 - 1. Backwater Valves.
 - 2. Cleanouts.
 - 3. Floor Drains.
 - 4. Floor Sinks.
 - 5. Channel Drainage Systems.
 - 6. Air-Admittance Valves.
 - 7. Roof Flashing Assemblies.
 - 8. Flashing Materials
 - 9. Through-Penetration Firestop Assemblies.
 - 10. Motors.
 - 11. Miscellaneous sanitary drainage piping specialties.

1.02 GENERAL REFERENCES

- A. Contract Documents: Refer to complete set of Contract Documents for requirements that are related to or may affect the work described in this Section.
- B. Division 20, including all Common Mechanical Requirements in Section 20 00 00, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.

1.03 RELATED REQUIREMENTS

- A. Division 07 Section "Sheet Metal Flashing and Trim" for penetrations of roofs.
- B. Division 07 Section "Penetration Firestopping" for firestopping roof penetrations.
- C. Section 20 05 00 - Common Mechanical Work Results for thermometers, pressure gages, and flow meters in domestic water piping.
- D. Section 22 10 05 - Plumbing Piping for water meters provided by the municipality.
- E. Section 22 32 10 - Domestic Water Filtration Equipment for municipal water filters in domestic water piping.

- F. Section 22 43 00 - Healthcare Plumbing Fixtures for thermostatic mixing valves for sitz baths, thermostatic mixing-valve assemblies for hydrotherapy equipment, and outlet boxes for dialysis equipment.
- G. Section 22 45 00 - Emergency Plumbing Fixtures for water tempering equipment.
- H. Section 22 47 00 - Drinking Fountains & Electric Water Coolers for water filters for water coolers.
- I. Section 22 43 00 - Healthcare Plumbing Fixtures for plaster sink interceptors.
- J. Division 33 Section "Stormwater Conveyance" for storm drainage piping and piping specialties outside the building.

1.04 REFERENCE STANDARDS

1.05 ABBREVIATIONS AND ACRONYMS

- A. AMI: Advanced Metering Infrastructure.
- B. AMR: Automatic Meter Reading.

1.06 PERFORMANCE REQUIREMENTS

- A. Domestic water piping specialties intended to convey or dispense water for human consumption are to comply with the SDWA, requirements of authorities having jurisdiction, and NSF 61 and NSF 372, or to be certified in compliance with NSF 61 and NSF 372 by an American National Standards Institute (ANSI)-accredited third-party certification body that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.
- B. For plastic components: NSF 14, mark "NSF-pw" on plastic piping components used in domestic water systems.
- C. Source Limitations
 - 1. Obtain each type of specialty from single source and from a single manufacturer. Coordinate products across all applicable size ranges to be from the same manufacturer.
- D. Domestic Water Piping Specialties
 - 1. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig (860 kPa) unless otherwise indicated.
 - 2. Product Data: For each type of product.
 - a. Include rated capacities, operating characteristics, and accessories for the following:
 - 1) FOG disposal systems.
 - 3. Shop Drawings: For domestic water piping specialties.
 - a. Include diagrams for power, signal, and control wiring as applicable.
 - 4. Shop Drawings:
 - a. Wiring Diagrams: Power, signal, and control wiring.
 - 5. Seismic Qualification Data: For FOG disposal systems, accessories, and components, from manufacturer.
 - a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
 - d. Field quality-control reports.
 - 6. Field quality-control reports.
 - 7. Sustainable Design Submittals: "Product Data" Subparagraph below applies to LEED 2009, LEED v4, IgCC, ASHRAE Std 189.1, and Green Globes for fixtures and equipment that consume water.
 - a. Product Data: For water consumption.

8. For domestic water piping specialties to include in emergency, operation, and maintenance manuals.
9. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - a. Cultures: Provide 1-gal. bottles of bacteria culture recommended by manufacturer of FOG disposal systems equal to 200 percent of amount installed, but no fewer than 2 1-gal. bottles.
10. For sanitary waste piping specialties to include in emergency, operation, and maintenance manuals.
11. Project Record Documents: Record actual locations of equipment, cleanouts, backflow preventers, and water hammer arrestors.

1.07 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.
- C. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with not less than three years documented experience.

1.08 DELIVERY, STORAGE AND HANDLING

- A. Accept specialties on site in original factory packaging. Inspect for damage.

1.09 EXTRA MATERIALS

- A. Extra Loose Keys for Outside Hose Bibbs: One.
- B. Extra Hose End Vacuum Breakers for Hose Bibbs: One.

PART 2 PRODUCTS

2.01 DOMESTIC WATER PIPING SPECIALTIES

- A. Vacuum Breakers
 1. Pipe-Applied, Atmospheric-Type Vacuum Breakers:
 - 1) Ames Fire & Waterworks; a division of Watts Water Technologies, Inc.
 - 2) Conbraco Industries, Inc.
 - 3) FEBCO; a division of Watts Water Technologies, Inc.
 - 4) Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - 5) Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
 - 6) Cash Acme; a division of Reliance Worldwide Corporation.
 - b. Standard: ASSE 1001.
 - c. Size: NPS 1/4 to NPS 3 (DN 8 to DN 80) , as required to match connected piping.
 - d. Body: Bronze.
 - e. Inlet and Outlet Connections: Threaded.
 - f. Finish: Chrome plated for exposed finished areas. Rough bronze for unfinished areas.
2. Hose-Connection Vacuum Breakers:
 - 1) Cash Acme; a division of Reliance Worldwide Corporation.
 - 2) Conbraco Industries, Inc.
 - 3) MIFAB, Inc.
 - 4) Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - 5) Woodford Manufacturing Company; a division of WCM Industries, Inc.

- 6) Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
 - b. Standard: ASSE 1011.
 - c. Body: Bronze, nonremovable, with manual drain.
 - d. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
 - 3. Pressure Vacuum Breakers:
 - 1) Ames Fire & Waterworks; a division of Watts Water Technologies, Inc.
 - 2) Conbraco Industries, Inc.
 - 3) FEBCO; a division of Watts Water Technologies, Inc.
 - 4) Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - 5) Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
 - b. Standard: ASSE 1020.
 - c. Operation: Continuous-pressure applications.
 - d. Pressure Loss: 5 psig (35 kPa) maximum, through middle third of flow range.
 - e. Accessories:
 - 1) Valves: Ball type, on inlet and outlet.
 - 4. Laboratory-Faucet Vacuum Breakers:
 - 1) Conbraco Industries, Inc.
 - 2) Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - 3) Woodford Manufacturing Company; a division of WCM Industries, Inc.
 - 4) Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
 - b. Standard: ASSE 1035.
 - c. Size: NPS 1/4 or NPS 3/8 (DN 8 or DN 10) matching faucet size.
 - d. Body: Bronze.
 - e. End Connections: Threaded.
 - f. Finish: Chrome plated.
 - 5. Spill-Resistant Vacuum Breakers:
 - 1) Conbraco Industries, Inc.
 - 2) Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - b. Standard: ASSE 1056.
 - c. Operation: Continuous-pressure applications.
 - d. Size: NPS 1/4 (DN 8).
 - e. Accessories:
 - 1) Valves: Ball type, on inlet and outlet.
- B. Backflow Preventers
- 1. Intermediate Atmospheric-Vent Backflow Preventers:
 - 1) Cash Acme; a division of Reliance Worldwide Corporation.
 - 2) Conbraco Industries, Inc.
 - 3) FEBCO; a division of Watts Water Technologies, Inc.
 - 4) Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - 5) Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
 - 6) Legend Valve.
 - b. Standard: ASSE 1012.
 - c. Operation: Continuous-pressure applications.
 - d. Size: See Drawings.
 - e. Body: Bronze.
 - f. End Connections: See Drawings.
 - 2. Reduced-Pressure-Principle Backflow Preventers:

- 1) Ames Fire & Waterworks; a division of Watts Water Technologies, Inc.
 - 2) Conbraco Industries, Inc.
 - 3) FEBCO; a division of Watts Water Technologies, Inc.
 - 4) Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - 5) Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
 - b. Standard: ASSE 1013.
 - c. Operation: Continuous-pressure applications.
 - d. Pressure Loss: 12 psig (83 kPa) maximum, through middle third of flow range.
 - e. Body: Bronze for NPS 2 (DN 50) and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved for NPS 2-1/2 (DN 65) and larger.
 - f. End Connections: Threaded for NPS 2 (DN 20) and smaller; flanged for NPS 2-1/2 (DN 65) and larger.
 - g. Configuration: Designed for horizontal, straight-through flow.
 - h. Accessories:
 - 1) Valves NPS 2 (DN 50) and Smaller: Ball type with threaded ends on inlet and outlet.
 - 2) Valves NPS 2-1/2 (DN 65) and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.
 - 3) Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.
3. Double-Check, Backflow-Prevention Assemblies:
 - 1) Ames Fire & Waterworks; a division of Watts Water Technologies, Inc.
 - 2) Conbraco Industries, Inc.
 - 3) FEBCO; a division of Watts Water Technologies, Inc.
 - 4) Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - 5) Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
 - b. Standard: ASSE 1015.
 - c. Operation: Continuous-pressure applications unless otherwise indicated.
 - d. Pressure Loss: 5 psig (35 kPa) maximum, through middle third of flow range.
 - e. Body: Bronze for NPS 2 (DN 50) and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved for NPS 2-1/2 (DN 65) and larger.
 - f. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 (DN 65) and larger.
 - g. Configuration: Designed for horizontal, straight-through flow.
 - h. Accessories:
 - 1) Valves NPS 2 (DN 50) and Smaller: Ball type with threaded ends on inlet and outlet.
 - 2) Valves NPS 2-1/2 (DN 65) and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.
4. Beverage-Dispensing-Equipment Backflow Preventers:
 - 1) Conbraco Industries, Inc.
 - 2) Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - 3) Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
 - b. Standard: ASSE 1022.
 - c. Operation: Continuous-pressure applications.
 - d. Size: NPS 1/4 or NPS 3/8 (DN 8 or DN 10).
 - e. Body: Stainless steel.
 - f. End Connections: Threaded.

5. Dual-Check-Valve Backflow Preventers:
 - 1) Cash Acme; a division of Reliance Worldwide Corporation.
 - 2) Conbraco Industries, Inc.
 - 3) FEBCO; a division of Watts Water Technologies, Inc.
 - 4) Mueller Co. Ltd.; a subsidiary of Mueller Water Products Inc.
 - 5) Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - 6) Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
 - b. Standard: ASSE 1024.
 - c. Operation: Continuous-pressure applications.
 - d. Body: Bronze with union inlet.
 6. Carbonated-Beverage-Dispenser, Dual-Check-Valve Backflow Preventers:
 - 1) Cash Acme; a division of Reliance Worldwide Corporation.
 - 2) Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - b. Standard: ASSE 1032.
 - c. Operation: Continuous-pressure applications.
 - d. Size: NPS 1/4 or NPS 3/8 (DN 8 or DN 10).
 - e. Body: Stainless steel.
 - f. End Connections: Threaded.
 7. Hose-Connection Backflow Preventers:
 - 1) Conbraco Industries, Inc.
 - 2) Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - 3) Woodford Manufacturing Company; a division of WCM Industries, Inc.
 - b. Standard: ASSE 1052.
 - c. Operation: Up to 10-foot head of water (30-kPa) back pressure.
 - d. Inlet Size: NPS 1/2 or NPS 3/4 (DN 15 or DN 20).
 - e. Outlet Size: Garden-hose thread complying with ASME B1.20.7.
 - f. Capacity: At least 3-gpm (0.19-L/s) flow.
 8. Backflow-Preventer Test Kits:
 - 1) Conbraco Industries, Inc.
 - 2) FEBCO; a division of Watts Water Technologies, Inc.
 - 3) Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - 4) Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
 - b. Description: Factory calibrated, with gages, fittings, hoses, and carrying case with test-procedure instructions.
 - 1) Cash Acme; a division of Reliance Worldwide Corporation.
 - 2) Conbraco Industries, Inc.
 - 3) Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - 4) Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
 - 5) CLA-VAL.
 - 6) Watts; a division of Watts Water Technologies, Inc.; Control Valves (Watts ACV).
 - 7) Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
- C. Automatic Water Shutoff Valve Systems
- a. Floodmaster.
 - b. The Detection Group.
 - c. Zurn Plumbing Products Group.
2. Shutoff Control Ball Valves and Actuators:

- a. Size: Same as applied pipe size.
- b. Control Valve: Two-piece, full-port bronze ball valve, MSS SP-110.
 - 1) End Connections: Threaded, female.
 - 2) Fittings: One 3/8-by-1/2-inch (9.5-by-12.7-mm) male compression and one 3/8-by-1/2-inch (9.5-by-12.7-mm) female compression.
 - 3) Seats: PTFE.
 - 4) O-Rings: FKM.
 - 5) Stem: Low-lead brass. Blowout proof.
 - 6) CWP Rating: 600 psig (4140 kPa).
- c. Manual-override control turn-knob for emergency operation of valve.
- d. Valve Actuator: Motor operated, with or without gears, electric and electronic. Capable of closing valve against inlet pressure. Direct mount, fails closed.
 - 1) Power Supply: Battery with cord and plug.
 - 2) Manual Intervention: Allowed.
 - 3) Position Indicator: Standard.
- e. Actuator Enclosure: Suitable for ambient conditions encountered by application.
- f. Wireless Leak Detection System:
 - 1) Sensor-Water Flow Type: Pipe-mounted to detect water flow.
 - 2) Sensor-Rope Type: Absorbent water sensing rope constructed from twisted metal conductor wires insulated from one another and surrounded by polyethylene mesh braid jacket to detect water presence.
 - 3) Wireless Signal Range: 100 feet (30.5 m) minimum between sensors and receiver.
 - 4) Self-monitoring enabled system; faults for lost communication between receiver and sensor(s).
 - 5) Onboard Battery Backup: 48 hours of protection. Valve to close prior to backup failure.
 - 6) LED Indicators: Wireless signal strength, communication loss, water fault, low-temperature fault, and low battery.
 - 7) FCC-Approved Wireless Communication System: Between sensors, repeaters, and receivers.
 - 8) Output Contacts: Interface with home security or BAS, cellular text notification service, or auto dialer accessories.
 - 9) Wireless Signal Repeater: Boosts signal performance between wireless sensors and receiver.
 - (a) Push-button pairing and unpairing, into and out of the network.
 - (b) Visual indication of wireless signal strength, low battery, and lost communication.
 - (c) Standard wall outlet, 120 V ac, power.
 - (d) Battery Backup: Two (2) AA batteries for battery backup to maintain system integrity during a power outage.
 - 10) Wireless Water Switch: Allows manual override or wireless system functionality and closes the valve to shut off water flow.
 - 11) Hard-Wired Water Switch: Allows manual override or wireless system functionality and closes the valve to shut off water flow.
- g. Wired Leak Detection System:
 - 1) Power Supply: Class II transformer with cord and plug, 120 V ac, UL listed.
 - 2) Power Cord Length: 12 feet (3.66 m).
 - 3) Control Panel: LED power and LED valves indicator.
 - 4) Alarms: Audible alarm, with external output.
 - 5) Output Contacts: Interface with home security or BAS, cellular text notification service, or auto dialer accessories.

- 6) Wired Sensors:
 - (a) Quantity Per Receiver: One.
- 7) Cable Length: 8 feet (2.44 m).
- 8) Cable Adder: 10 feet (3 m) in length.
- 3. Clothes Washer Shutoff Control Valve and Actuator:
 - a. Brass or stainless steel ball valve.
 - b. End Connections: Male hose connections, NPS 3/4 (DN 20).
 - c. Pressure Rating: 400 psi (2758 kPa) at 32 to 150 deg F (0 to 65.6 deg C).
 - d. Valve Actuator:
 - 1) Enclosure: Suitable for ambient conditions encountered by application.
 - 2) Power Supply: Battery with cord and plug.
 - 3) Position Indicator: Standard.
 - e. Wired Leak Detection System:
 - 1) Water sensor with minimum 6-foot (1.8-m) length of wire.
 - 2) 120 V ac step-down transformer with cord and plug.
 - 3) LED operation and leak notification.
 - 4) Audible alarm.
 - 5) Power failure or manual disconnection of power causes valves to close.
- 4. Accessories:
 - a. Electrical Plug Interrupter: Plugs into standard 120 V ac wall outlet.
 - b. Gas Flow Interrupter: ECO connector with female spade connectors. Factory prewired, 8 feet (2.44 m).
 - c. Gas Interface Cable: Interface cable with male and female connectors.
 - d. Step-Down Transformer: 120 V ac to 24 V ac with mounting plate, 12-foot (3.66-m) plenum wire to power, and 8-foot (2.44-m) plenum wire to sensor.
 - e. Liquid Level Sensors: Monitor fluid levels in addition to detecting plumbing leaks.
 - f. Auto Dialer: Send and receive automatic alerts when a fault condition occurs. Standard output contacts trigger up to nine predetermined telephone number calls.
 - 1) Prerecord message for future playback.
 - 2) 10-second recordable message.
 - 3) Built-in tamper switch.
 - 4) DC adaptor with battery backup.
 - 5) Programmable as a silent (dialer only) or audible (siren and dialer) alarm.
 - 6) Easy "Stop Call Sequence" - push "#" on phone to acknowledge the alarm and stop the dialing sequence.
 - g. Cellular Text Notification System:
 - 1) Event SMS text notification to up to three cell phones.
 - 2) Battery Backup: Four (4) AA batteries.
 - 3) 12-foot (3.66-m) interface cable to leak detection system.
 - 4) Customized messaging.
- D. Mechanical Balancing Valves
 - 1. Copper-Alloy Calibrated Balancing Valves:
 - 1) Armstrong International, Inc.
 - 2) NIBCO Inc.
 - 3) TACO Incorporated.
 - 4) Jomar Valve.
 - 5) Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - b. Type: Ball valve with two readout ports and memory-setting indicator.
 - c. Body: Lead free brass or bronze.
 - d. Size: Same as connected piping, but not larger than NPS 2 (DN 50).

- e. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.
- 2. Automatic Flow Control Balancing Valves:
 - 1) Calefi North America.
 - 2) ThermOmegaTech.
 - 3) Hays Fluid Controls.
 - 4) Jomar Valve
 - b. Flow Regulation: Plus or minus 5 percent over 95 percent of the working range.
 - c. Pressure Rating: 200 psig (1380 kPa).
 - d. Size: NPS 2 (DN 50) or smaller.
 - e. Body: Stainless steel or brass.
 - f. Flow Cartridge: Stainless steel or antiscall polymer.
 - g. End Connections: Threaded or solder joint
- 3. Memory-Stop Balancing Valves:
 - 1) Conbraco Industries, Inc.
 - 2) Crane Co.; Crane Valve Group; Crane Valves.
 - 3) Crane Co.; Crane Valve Group; Jenkins Valves.
 - 4) Crane Co.; Crane Valve Group; Stockham Div.
 - 5) Hammond Valve.
 - 6) Milwaukee Valve Company.
 - 7) NIBCO Inc.
 - 8) Red-White Valve Corp.
 - b. Standard: MSS SP-110 for two-piece, copper-alloy ball valves.
 - c. Pressure Rating: 400-psig (2760-kPa) minimum CWP.
 - d. Size: NPS 2 (DN 50) or smaller.
 - e. Body: Copper alloy.
 - f. Port: Standard or full port.
 - g. Ball: Chrome-plated brass.
 - h. Seats and Seals: Replaceable.
 - i. End Connections: Solder joint or threaded.
 - j. Handle: Vinyl-covered steel with memory-setting device.
- E. Digital Balancing and Flushing Valves
 - 1. Master Control Boxes
 - 1) Georg Fischer, LLC
 - b. Master control panel shall comply with the following requirements:
 - 1) Control up to 50 controllers on two cable harnesses.
 - (a) Distance: Without the use of a power box, each cable harness is capable of a maximum distance from the master of 984 ft (300 m) With the use of a power box, each cable harness is capable of a maximum distance from the master of 1640 ft (500 m).
 - 2) Touchscreen Display: Home, running application, manual operation, settings, reports, context-sensitive help and additional displays.
 - 3) Connections: Potential-free contact connection, USB connection, USV connection, Ethernet connection, connection for building management system, two M12 communication cable connections, Bluetooth, power supply connection.
 - 4) Constant monitoring and control of individual valves and sensors.
 - 5) Automatic data logging.
 - 6) Automated valve maintenance.
 - 7) Export of reports in .pdf or .xml format.
 - 8) Wall-mounted.

- 9) Electrical Requirements: 110V power supply connection. Master converts 110V supply power to 36V.
2. Power Boxes
 - 1) Georg Fischer, LLC
 - b. The power box shall comply with the following requirements:
 - 1) Provides additional power for cable lengths in excess of 984 ft. / 300 m.
 - 2) LED indicating power on/off.
 - 3) Connections: Power supply connection, two M12 communication cable connections.
 - 4) Wall-mounted.
 - 5) Electrical Requirements: 110V power supply connection. Converts 110V supply power to 36V.
3. Digital Balancing Valves
 - 1) Georg Fischer, LLC
 - b. The digital balancing valve shall comply with the following requirements:
 - 1) Fully automated dynamic balancing valve.
 - 2) Controller includes motor actuator with encoder.
 - 3) Connections: Two M12 plug, PT1000 plug, M8 plug.
 - 4) Maximum operating pressure up to 145 psi.
 - 5) Maximum temperature up to 194 deg F.
 - 6) Two calibration temperatures (normal operation/thermal disinfection).
 - 7) Factory temperature settings.
 - (a) Normal operation: 134 deg F (setting range 32 deg F – 194 deg F)
 - 8) Control accuracy < ± 1.8 deg F.
 - 9) Completely emerged temperature sensor PT1000 integrated in the valve.
 - 10) On/off option of Bluetooth connection to external tablet/smartphone.
 - 11) Activity indicator (LED light ring).
 - 12) EPDM O-ring.
 - 13) Male threaded end connections.
 - c. Custom insulation block.
 - 1) Automated weekly maintenance.
 - 2) 36V power supply.
4. Digital Flushing Valves
 - 1) Georg Fischer, LLC
 - b. The digital flushing valve shall comply with the following requirements:
 - 1) Fully automated flushing valve.
 - 2) Controller includes motor actuator with encoder.
 - 3) Connections: Two M12 plug, PT1000 plug, M8 plug.
 - 4) Adjustable lift: flow rate with open valve.
 - 5) Maximum operating pressure up to 145 psi.
 - 6) Maximum temperature up to 194 deg F.
 - 7) Two calibration modes (temperature or timed flushing).
 - 8) Factory temperature setting: 77 deg F (setting range 35 deg F – 194 deg F).
 - 9) Control accuracy < ± 1.8 deg F.
 - 10) Completely emerged temperature sensor PT1000 integrated in the valve.
 - 11) On/off option of Bluetooth connection to external tablet/smartphone.
 - 12) Activity indicator (LED light ring).
 - 13) EPDM O-ring.
 - 14) End Connections: Threaded.
 - 15) Custom insulation block.
 - 16) 36V power supply.

- F. Mechanical Temperature-Actuated Balancing Valves
 - 1. Stainless Steel Self-Acting Thermostatic Recirculation Valve
 - 1) Circuit Solver, a ThermOmegaTech Division
 - b. Standards: NSF 61 and California AB1953 Certified.
 - c. Pressure Rating: 300-psig (2068-kPa) maximum CWP.
 - d. Size: NPS 2 (DN 50) or smaller.
 - e. Body: Type 303 Stainless Steel.
 - f. End Connections: threaded.
- G. Flow-Splitter Valves
 - 1. Venturi Flow-Splitter: Lead-free, corrosion resistant red brass dual tee assembly valve with internal, self-adjusting flow regulator including factory loop line 1/4 turn shut off valves and factory insulation jacket.
 - 1) Kemper Water Control Systems, IncL.
 - b. Standards: NSF 61/NSF 372 certified
 - c. Body: zinc resistant red brass.
 - d. Sizes: 1/2" to 2" in the main flow portion of the valve.
 - e. Features: Built-in, self-regulating, self-cleaning, flow diverting POM cartridge insert with SS spring and EPDM O-ring, 1/4 turn full bore stop valves on loop line connections
 - f. End Connections: Threaded.
 - g. Temperature Rating: Maximum operating temperature 194 deg F (90 deg C)
 - h. Pressure Rating: 225-psig (2068-kPa) maximum
- H. Temperature-Actuated, Water Mixing Valves
 - 1. Water-Temperature Limiting Devices (Point of use):
 - 1) Armstrong International, Inc.
 - 2) Cash Acme; a division of Reliance Worldwide Corporation.
 - 3) Conbraco Industries, Inc.
 - 4) Leonard Valve Company.
 - 5) Powers; a division of Watts Water Technologies, Inc.
 - 6) Symmons Industries, Inc.
 - 7) Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - 8) Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
 - b. Standard: ASSE 1070.
 - c. Pressure Rating: 125 psig (860 kPa).
 - d. Type: Thermostatically controlled, water mixing valve.
 - e. Material: Bronze body with corrosion-resistant interior components.
 - f. Connections: Threaded union inlets and outlet.
 - g. Accessories: Check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
- 2. Primary, Thermostatic, Water Mixing Valves:
 - 1) Acorn Engineering Company.
 - 2) Apollo Valves; Conbraco Industries, Inc.
 - 3) Armstrong International, Inc.
 - 4) Lawler Manufacturing Company, Inc.
 - 5) Leonard Valve Company.
 - 6) POWERS; A WATTS Brand.
 - 7) Symmons Industries, Inc.
- b. Standard: ASSE 1017.
- c. Pressure Rating: 125 psig (860 kPa) minimum unless otherwise indicated.
- d. Material: Bronze body with corrosion-resistant interior components.

- e. Connections: Threaded inlets and outlet.
 - f. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
 - g. Valve Finish: Chrome plated.
 - h. Piping Finish: Chrome plated.
 - i. Cabinet: Factory fabricated, stainless steel, for recessed mounting and with hinged, stainless-steel door.
3. Primary, Digital/Electronic, Water Mixing Valve Assemblies:
- 1) Acorn Engineering Company.
 - 2) Armstrong International, Inc.
 - 3) Lawler Manufacturing Company, Inc.
 - 4) Leonard Valve Company.
 - 5) POWERS; A WATTS Brand.
 - b. Standard: ASSE 1017.
 - c. Pressure Rating: 125 psig (860 kPa) minimum unless otherwise indicated.
 - d. Type: Exposed, electronically controlled, water mixing valve.
 - e. Material: Bronze body with corrosion-resistant interior components.
 - f. Connections: Threaded or solder joint inlets and outlet.
 - g. Accessories: Manual temperature override control, check stops on hot- and cold-water supplies, and automatic hot- and cold-water shutoff upon inlet supply failure.
 - h. Tempered-Water Setting: See Drawings.
 - i. Tempered-Water Design Flow Rate: See Drawings.
 - j. Selected Valve Flow Rate at 45-psig (310-kPa) Pressure Drop: See Drawings.
 - k. Pressure Drop at Design Flow Rate: See Drawings.
 - l. Valve Finish: Bronze.
 - m. Digital temperature control and monitoring module.
 - 1) Controls temperature within plus or minus 2 deg F (1 deg C).
 - 2) User programmable at module or through BAS.
 - 3) Local and remote monitoring.
 - 4) BACNet protocol language(s).
 - 5) 115 V ac, 60 Hz.
 - n. Battery backup.
4. Individual-Fixture, Water Tempering Valves:
- 1) Acorn Engineering Company.
 - 2) Apollo Valves; Conbraco Industries, Inc.
 - 3) Armstrong International, Inc.
 - 4) Lawler Manufacturing Company, Inc.
 - 5) Leonard Valve Company.
 - 6) POWERS; A WATTS Brand.
 - 7) Symmons Industries, Inc.
 - b. Standard: ASSE 1016, thermostatically controlled, water tempering valve.
 - c. Pressure Rating: 125 psig (860 kPa) minimum unless otherwise indicated.
 - d. Material: Bronze body with corrosion-resistant interior components.
 - e. Temperature Control: Adjustable.
 - f. Connections: Threaded inlets and outlet.
 - g. Finish: Chrome plated.
- I. Strainers
1. Y-Pattern Strainers:
- 1) Conbraco Industries, Inc; Apollo Valves
 - 2) Hammond Valve
 - 3) Milwaukee Valve Company: CL Series

- 4) NIBCO INC
 - 5) Jomar Valve
 - b. Pressure Rating: 125 psig (860 kPa) minimum unless otherwise indicated.
 - c. Body: Bronze for NPS 2 (DN 50) and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved, epoxy coated and for NPS 2-1/2 (DN 65) and larger.
 - d. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 (DN 65) and larger.
 - e. Screen: Stainless steel with round perforations unless otherwise indicated.
 - f. Perforation Size:
 - 1) Strainers NPS 2 (DN 50) and Smaller: 0.020 inch (0.51 mm).
 - 2) Strainers NPS 2-1/2 to NPS 4 (DN 65 to DN 100): 0.045 inch (1.14 mm).
 - 3) Strainers NPS 5 (DN 125) and Larger: 0.10 inch (2.54 mm).
 - g. Drain: Factory-installed, hose-end drain valve.
 - 1) Acorn Engineering Company.
 - 2) Guy Gray Manufacturing Co., Inc.
 - 3) Oatey.
 - 4) Symmons Industries, Inc.
 - 5) Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - 6) Whitehall Manufacturing; a div. of Acorn Engineering Company.
 - 7) Zurn Industries, LLC; Plumbing Products Group; Light Commercial Products.
 - 8) IPS Corporation.
 - 9) Acorn Engineering Company.
 - 10) Oatey.
 - 11) IPS Corporation.
 - h. Armstrong International, Inc.
 - i. Leonard Valve Company.
 - j. T & S Brass.
 - k. Chicago Faucets
- J. Hose Bibbs
- 1. Hose Bibbs:
 - a. Standard: ASME A112.18.1 for sediment faucets.
 - b. Body Material: Bronze.
 - c. Seat: Bronze, replaceable.
 - d. Supply Connections: NPS 1/2 or NPS 3/4 (DN 15 or DN 20) threaded or solder-joint inlet.
 - e. Outlet Connection: Garden-hose thread complying with ASME B1.20.7
 - f. Pressure Rating: 125 psig (860 kPa).
 - g. Vacuum Breaker: Integral or field-installation, nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
 - h. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
 - i. Finish for Service Areas: Rough bronze.
 - j. Finish for Finished Rooms: Chrome or nickel plated.
 - k. Operation for Equipment Rooms: Wheel handle or operating key.
 - l. Operation for Service Areas: Operating key.
 - m. Operation for Finished Rooms: Operating key.
 - n. Operation for Finished Rooms: Operating key.
 - o. Include operating key with each operating-key hose bibb.
 - p. Include integral wall flange with each chrome- or nickel-plated hose bibb.
- K. Wall Hydrants
- 1. Nonfreeze Wall Hydrants:

- 1) Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - 2) Watts.
 - 3) Woodford Manufacturing Company; a division of WCM Industries, Inc.
 - 4) Zurn Industries, LLC; Plumbing Products Group; Light Commercial Products.
 - 5) Prier Products, Inc.
- b. Inlet: NPS 3/4 or NPS 1 (DN 20 or DN 25).
- c. Standard: ASME A112.21.3M for concealed-outlet, self-draining wall hydrants.
- d. Pressure Rating: 125 psig (860 kPa).
- e. Operation: Loose key.
- f. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
- g. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
- h. Box: Deep, flush mounted with cover.
- i. Box and Cover Finish: Polished nickel bronze.
- j. Outlet: Exposed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
- k. Nozzle and Wall-Plate Finish: Polished nickel bronze.
- l. Operating Keys(s): One with each wall hydrant.
2. Nonfreeze, Hot- and Cold-Water Wall Hydrants:
 - 1) Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - 2) Watts.
 - 3) Woodford Manufacturing Company; a division of WCM Industries, Inc.
 - 4) Zurn Industries, LLC.
- b. Standard: ASME A112.21.3M for concealed-outlet, self-draining wall hydrants.
- c. Pressure Rating: 125 psig (860 kPa).
- d. Operation: Loose key.
- e. Casing and Operating Rods: Of length required to match wall thickness. Include wall clamps.
- f. Inlet: NPS 3/4 or NPS 1 (DN 20 or DN 25).
- g. Outlet: Concealed.
- h. Box: Deep, flush mounted with cover.
- i. Box and Cover Finish: Polished nickel bronze.
- j. Vacuum Breaker:
 - 1) Nonremovable, manual-drain-type, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.
 - 2) Garden-hose thread complying with ASME B1.20.7 on outlet.
- k. Operating Keys(s): One with each wall hydrant.
3. Moderate-Climate Wall Hydrants:
 - 1) Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - 2) Watts.
 - 3) Woodford Manufacturing Company; a division of WCM Industries, Inc.
 - 4) Zurn Industries, LLC.
- b. Standard: ASME A112.21.3M for concealed-outlet, self-draining wall hydrants.
- c. Pressure Rating: 125 psig (860 kPa).
- d. Operation: Loose key.
- e. Inlet: NPS 3/4 or NPS 1 (DN 20 or DN 25).
- f. Concealed, with integral vacuum breaker or nonremovable hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.
- g. Garden-hose thread complying with ASME B1.20.7.
- h. Box: Deep, flush mounted with cover.

- i. Box and Cover Finish: Polished nickel bronze.
- j. With integral vacuum breaker or nonremoveable hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.
- k. Garden-hose thread complying with ASME B1.20.7.
- l. Nozzle and Wall-Plate Finish: Polished nickel bronze.
- m. Operating Keys(s): One with each wall hydrant.
- 4. Vacuum Breaker Wall Hydrants:
 - 1) Jay R. Smith Mfg. Co.
 - 2) Watts; a division of Watts Water Technologies, Inc.
 - 3) Woodford Manufacturing Company; a division of WCM Industries, Inc.
 - 4) Zurn Industries, LLC.
 - b. Standard: ASSE 1019, Type A or Type B.
 - c. Type: Freeze-resistant, automatic draining with integral air-inlet valve.
 - d. Classification: Type A, for automatic draining with hose removed or Type B, for automatic draining with hose removed or with hose attached and nozzle closed.
 - e. Pressure Rating: 125 psig (860 kPa).
 - f. Operation: Loose key or wheel handle.
 - g. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
 - h. Inlet: NPS 1/2 or NPS 3/4 (DN 15 or DN 20).
 - i. Outlet: Exposed with garden-hose thread complying with ASME B1.20.7.
 - 1) Smith, Jay R. Mfg.
 - 2) Watts.
 - 3) Woodford Manufacturing Company; a division of WCM Industries, Inc.
 - 4) Zurn Industries, LLC.
 - 5) Smith, Jay R. Mfg. Co.
 - 6) Watts.
 - 7) Woodford Manufacturing Company; a division of WCM Industries, Inc.
 - 8) Zurn Industries, LLC.
 - 9) Jay R. Smith Mfg. Co.
 - 10) Josam Company.
 - 11) WATTS.
 - 12) Woodford Manufacturing Company.
 - 13) Jay R. Smith Mfg. Co.
 - 14) Josam Company.
 - 15) WATTS.
 - 16) Woodford Manufacturing Company.
 - 17) Zurn Plumbing Products.
- L. Water-Hammer Arresters
 - 1. Water-Hammer Arresters:
 - 1) Jay R. Smith Mfg. Co.
 - 2) Mifab, Inc
 - 3) Precision Plumbing Products.
 - 4) Sioux Chief Manufacturing Company, Inc.
 - 5) WATTS.
 - 6) Zurn
 - b. Standard: Certified ANSI/ASSE 1010-2004 or PDI-WH 201-2017, NSF 372.
 - c. Type:
 - 1) Body: Seamless Type-L Copper tube with piston.
 - 2) Piston: Poly Piston with two EPDM O-Rings.
 - 3) Piston Lubrication: Dow-Corning, 111 FDA Approved Silicone Compound.

- 4) Solder: Lead Free.
- 5) Male MIP Thread Fitting.
- d. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201-2017, Sizes A through F.

M. Air Vents

- 1. Bolted-Construction Automatic Air Vents:
 - a. Body: Bronze.
 - b. Pressure Rating and Temperature: 125-psig (860-kPa) minimum pressure rating at 140 deg F (60 deg C).
 - c. Float: Replaceable, corrosion-resistant metal.
 - d. Mechanism and Seat: Stainless steel.
 - e. Size: NPS 3/8 (DN 10) minimum inlet.
 - f. Inlet and Vent Outlet End Connections: Threaded.
- 2. Welded-Construction Automatic Air Vents:
 - a. Body: Stainless steel.
 - b. Pressure Rating: 150-psig (1035-kPa) minimum pressure rating.
 - c. Float: Replaceable, corrosion-resistant metal.
 - d. Mechanism and Seat: Stainless steel.
 - e. Size: NPS 3/8 (DN 10) minimum inlet.
 - f. Inlet and Vent Outlet End Connections: Threaded.

N. Pressure Trap-Seal Primer Device

- 1. Trap-Seal Primer Systems:
 - 1) Precision Plumbing Products, Inc.
 - 2) MIFAB, Inc.
 - 3) Zurn.
 - 4) Smith, Jay R. Mfg. Co.
- b. Standard: ASSE 1018.
- c. Pressure Rating: 125 psig (860 kPa) minimum.
- d. Body: Bronze.
- e. Inlet and Outlet Connections: NPS 1/2 (DN 15) threaded, union, or solder joint.
- f. Gravity Drain Outlet Connection: NPS 1/2 (DN 15) threaded or solder joint.
- g. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.

O. Electronic Trap-Seal Primer Systems

- 1. Trap-Seal Primer Systems:
 - 1) Precision Plumbing Products, Inc.
 - 2) MIFAB, Inc.
 - 3) Zurn.
 - 4) Smith, Jay R. Mfg. Co.
- b. Standard: ASSE 1044.
- c. Inlet Size: NPS 3/4, ASTM B88, Type L (DN 20, ASTM B88M, Type B); copper, water tubing.
- d. Cabinet: Recessed-mounted steel box with stainless-steel cover.
- e. Electric Controls: 24-hour timer, solenoid valve, and manual switch for 120-V ac power.
 - 1) Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- f. Vacuum Breaker: ASSE 1001.
- g. Number Outlets: Four.
- h. Size Outlets: NPS 1/2 (DN 15).

- 1) AALIANT; a Venture Measurement product line.
- 2) ABB.
- 3) Badger Meter, Inc.
- 4) Carlon Meter.
- 5) Mueller Co. Ltd.; a subsidiary of Mueller Water Products Inc.
- 6) Schlumberger Limited; Water Services.
- 7) Neptune Technology Group.
- 8) Niagra Meters.
- 9) ABB.
- 10) Badger Meter, Inc.
- 11) Mueller Co. Ltd.; a subsidiary of Mueller Water Products Inc.
- 12) Schlumberger Limited; Water Services.
- 13) Neptune Technology Group.
- 14) Niagra Meters.
- 15) ABB.
- 16) Badger Meter, Inc.
- 17) Master Meter, Inc.
- 18) Mueller Co. Ltd.; a subsidiary of Mueller Water Products Inc.
- 19) Schlumberger Limited; Water Services.
- 20) Neptune Technology Group.
- 21) Niagra Meters.
- 22) Badger Meter, INC
- 23) Master Meter, INC.
- 24) Neptune Technology Group

2.02 SANITARY WASTE PIPING SPECIALTIES

A. Backwater Valves

1. Horizontal, Cast-Iron Backwater Valves:
 - 1) Josam Company.
 - 2) MIFAB, Inc.
 - 3) Smith, Jay R. Mfg. Co.
 - 4) Watts Water Technologies, Inc.
 - 5) Zurn Plumbing Products Group; Specification Drainage Operation.
- b. Standard: ASME A112.14.1.
- c. Size: Same as connected piping.
- d. Body: Cast iron.
- e. Cover: Cast iron with bolted access check valve.
- f. End Connections: Hub and spigot or hubless.
- g. Type Check Valve: Removable, bronze, swing check, factory assembled or field modified to hang closed.
- h. Extension: ASTM A74, Service class; full-size, cast-iron, soil-pipe extension to field-installed cleanout at floor; replaces backwater valve cover.
- i. Josam Company.
- j. Smith, Jay R. Mfg. Co.
- k. Watts Water Technologies, Inc.
- l. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.14.1.
3. Size: Same as floor drain outlet.
4. Body Material: Cast iron or bronze made for vertical installation in bottom outlet of floor drain.
5. Check Valve: Removable ball float.
6. Inlet: Threaded or no-hub.

7. Outlet: Threaded, no-hub, or spigot.
 8. Horizontal, Plastic Backwater Valves:
 - 1) Oatey.
 - 2) Sioux Chief Manufacturing Company, Inc.
 - 3) Zurn Plumbing Products Group; Light Commercial Products Operation.
 - 4) IPS Corporation.
 - b. Standard: ASME A112.14.1.
 - c. Size: Same as connected piping.
 - d. Body: PVC.
 - e. Cover: Same material as body with threaded access to check valve.
 - f. Check Valve: Removable swing check.
 - g. End Connections: Socket type.
 - h. Stainless-Steel Exposed Cleanouts:
- B. Cleanouts
1. Exposed Metal Cleanouts:
 - 1) Josam Company.
 - 2) MIFAB, Inc.
 - 3) Smith, Jay R. Mfg. Co.
 - 4) Tyler Pipe.
 - 5) Watts Water Technologies, Inc.
 - 6) Zurn Plumbing Products Group; Specification Drainage Operation.
 - b. Standard: ASME A112.36.2M.
 - c. Size: Same as connected drainage piping
 - d. Body Material: Hubless, cast-iron soil pipe test tee as required to match connected piping.
 - e. Closure: Countersunk or Raised-head, brass plug.
 - f. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
 - g. Stainless-Steel Exposed Cleanouts:
 - (a) Josam Company.
 - 2) Standard: ASME A112.3.1 for cleanout test tee.
 - 3) Size: Same as connected drainage piping
 - 4) Body Material: Stainless-steel tee with side cleanout as required to match connected piping.
 - 5) Closure: Stainless-steel plug with seal.
 2. Cast-Iron Exposed Floor Cleanouts:
 - 1) Josam Company.
 - 2) Smith, Jay R. Mfg. Co.
 - 3) Tyler Pipe.
 - 4) Watts Water Technologies, Inc.
 - 5) Zurn Plumbing Products Group; Specification Drainage Operation.
 - b. Standard: ASME A112.36.2M for heavy-duty, adjustable housing cleanout.
 - c. Size: Same as connected branch.
 - d. Type: Heavy-duty, adjustable housing.
 - e. Body or Ferrule Material: Cast iron.
 - f. Clamping Device: Required.
 - g. Outlet Connection: Spigot.
 - h. Closure: Brass, bronze or plastic with tapered threads.
 - i. Adjustable Housing Material: Cast iron with threads, set-screws or other device.
 - j. Frame and Cover Material and Finish: Nickel-bronze, copper alloy. In finished areas provide a recessed cover for finished floor material.
 - k. Frame and Cover Shape: Round.

- l. Top-Loading Classification: Extra-Heavy Duty.
 - m. Riser: ASTM A74, Service class, cast-iron drainage pipe fitting and riser to cleanout.
 - 3. Stainless-Steel Exposed Floor Cleanouts:
 - 1) Josam Company.
 - 2) Zurn Industries, LLC.
 - 3) Kusel Equipment Co.
 - b. Standard: ASME A112.3.1.
 - c. Size: Same as connected branch.
 - d. Housing: Stainless steel.
 - e. Closure: Stainless steel with seal.
 - f. Riser: ASTM A74, Service Extra-Heavy class, stainless-steel drainage pipe fitting and riser to cleanout.
 - g. Body or Ferrule Material: Stainless steel.
 - h. Clamping Device: Required.
 - i. Outlet Connection: Spigot.
 - j. Closure: Brass or plastic with tapered threads.
 - k. Adjustable Housing Material: Cast iron with threads, set-screws or other device.
 - l. Frame and Cover Material and Finish: Nickel-bronze, copper alloy. In finished areas provide a recessed cover for finished floor material.
 - m. Top-Loading Classification: Medium Duty.
 - 4. Cast-Iron Wall Cleanouts:
 - 1) Josam Company.
 - 2) MIFAB, Inc.
 - 3) Smith, Jay R. Mfg. Co.
 - 4) Tyler Pipe.
 - 5) Watts Water Technologies, Inc.
 - 6) Zurn Plumbing Products Group; Specification Drainage Operation.
 - b. Standard: ASME A112.36.2M. Include wall access.
 - c. Size: Same as connected drainage piping.
 - d. Body: Hubless, cast-iron soil pipe test tee as required to match connected piping.
 - e. Closure Plug:
 - 1) Brass.
 - 2) Countersunk head.
 - 3) Drilled and threaded for cover attachment screw.
 - 4) Size: Same as or not more than one size smaller than cleanout size.
 - f. Wall Access: Round, deep, chrome-plated bronze cover plate with screw.
 - g. Wall Access: Round, nickel-bronze, copper-alloy, or stainless steel wall-installation frame and cover.
 - 5. Test Tees:
 - 1) Jay R. Smith Mfg. Co.; a division of Morris Group International.
 - 2) Tyler Pipe; a subsidiary of McWane Inc.
 - 3) Watts Water Technologies; a Watts company.
 - 4) Zurn Industries, LLC.
 - b. Standard: ASME A112.36.2M and ASTM A74, ASTM A888, or CISPI 301.
 - c. Size: Same as connected drainage piping.
 - d. Body Material: Hub-and-spigot, cast-iron soil-pipe T-branch or no-hub, cast-iron soil-pipe test tee as required to match connected piping.
 - e. Closure Plug: Countersunk or raised head, brass.
 - f. Closure Plug Size: Same as, or not more than, one size smaller than cleanout size.
- C. Floor Drain
 - 1. Cast-Iron Floor Drains:

- 1) Josam Company.
 - 2) MIFAB, Inc.
 - 3) Smith, Jay R. Mfg. Co.
 - 4) Tyler Pipe.
 - 5) Watts Water Technologies, Inc.
 - 6) Zurn Plumbing Products Group; Light Commercial Products Operation.
 - 7) Zurn Plumbing Products Group; Specification Drainage Operation.
 - b. Standard: ASME A112.6.3 with backwater valve.
 - c. Pattern: Area drain.
 - d. Body Material: Gray iron.
 - e. Seepage Flange: Required.
 - f. Anchor Flange: Not required.
 - g. Clamping Device: Required.
 - h. Outlet: Bottom.
 - i. Backwater Valve: Not required.
 - j. Coating on Interior and Exposed Exterior Surfaces: Not required.
 - k. Sediment Bucket: Not required.
 - l. Top or Strainer Material: Nickel bronze.
 - m. Top Shape: Round.
 - n. Dimensions of Top or Strainer:
 - o. Top Loading Classification: Extra-Heavy Duty. Drains located in Corridors and other occupied spaces shall be heavy duty loading.
 - p. Funnel: Not required.
 - q. Inlet Fitting: Not required.
 - r. Trap Material: Bronze.
 - s. Trap Pattern: Deep-seal P-trap.
 - t. Trap Features: Cleanout.
 2. Stainless-Steel Floor Drains:
 - 1) Josam Company.
 - 2) Smith, Jay R. Mfg. Co.
 - 3) Tyler Pipe.
 - 4) Watts Drainage Products.
 - 5) Zurn Plumbing Products Group.
 - 6) Kusel Equipment Co.
 - 7) Scherping Systems, Inc.
 - b. Standard: ASME A112.3.1.
 - c. Outlet: Bottom.
 - d. Top or Strainer Material: Stainless steel.
 - e. Top Shape: Round.
 - f. Dimensions of Top or Strainer:
 - g. Seepage Flange: Not required.
 - h. Anchor Flange: Not required.
 - i. Clamping Device: Not required.
 - j. Trap-Primer Connection: Not required.
 - k. Trap Material: Cast iron.
 - l. Trap Pattern: Deep-seal P-trap.
- D. Floor Sinks
 1. Cast-Iron Floor Sinks:
 - 1) Commercial Enameling Co.
 - 2) Josam Company; Josam Div.
 - 3) Mifab.

- 4) Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - 5) Tyler Pipe; Wade Div.
 - 6) Watts Drainage Products Inc.
 - 7) Zurn Plumbing Products Group; Light Commercial Operation.
 - 8) Zurn Plumbing Products Group; Specification Drainage Operation.
 - b. Standard: ASME A112.6.7.
 - c. Pattern: Floor drain.
 - d. Body Material: Cast iron.
 - e. Clamping Device: Not required.
 - f. Outlet: Bottom, no-hub connection.
 - g. Coating on Interior Surfaces: Not required.
 - h. Sediment Bucket: Not required.
 - i. Internal Strainer: Not required.
 - j. Internal Strainer Material: Aluminum.
 - k. Top of Body and Grate Finish: Nickel bronze.
 - l. Top Shape: Round.
 - m. Dimensions of Top Grate: _____.
 - n. Top Loading Classification: No traffic.
 - o. Funnel: Not required.
 - 2. Stainless-Steel Floor Sinks
 - 1) Josam Company; Josam Div.
 - 2) Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - 3) Tyler Pipe; Wade Div.
 - 4) Watts Drainage Products Inc.
 - 5) Zurn Plumbing Products Group; Specification Drainage Operation.
 - b. Standard: ASME A112.6.7.
 - c. Pattern: Floor drain.
 - d. Body Material: Stainless steel.
 - e. Anchor Flange: Not required, with seepage holes.
 - f. Clamping Device: Not required.
 - g. Outlet: Bottom, no-hub connection.
 - h. Sediment Bucket: Not required.
 - i. Internal Strainer: Not required.
 - j. Internal Strainer Material: Stainless steel.
 - k. Top Grate Material: Stainless steel, loose.
 - l. Top of Body and Grate Finish: Satin nickel.
 - m. Top Shape: Round.
 - n. Dimensions of Top Grate: _____.
 - o. Top Loading Classification: No traffic.
 - p. Funnel: Not required.
 - 1) Josam Company.
 - 2) MIFAB, Inc.
 - 3) Smith, Jay R. Mfg. Co.
 - 4) Tyler Pipe.
 - 5) Watts Water Technologies, Inc.
 - 6) Zurn Plumbing Products Group; Specification Drainage Operation.
- E. Channel Drainage Systems
 - 1. Stainless-Steel Channel Drainage Systems:
 - a. Stainless-Steel Channel Drainage Systems:
 - (a) Josam Company; Blucher-Josam Div.
 - (b) Mifab.

- (c) Zurn Plumbing Products Group; Flo-Thru Operation.
- b. Type: Modular system of stainless-steel channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
- 1) Standard: ASME A112.3.1, for trench drains.
 - 2) Channel Sections: Interlocking-joint, stainless-steel with level invert.
 - (a) Dimensions: 5.8 inches wide. Include number of units required to form total lengths indicated.
 - 3) Grates: Manufacturer's designation "heavy duty," with slots or perforations, and of width and thickness that fit recesses in channels.
 - (a) Material: Ductile iron.
 - (b) Locking Mechanism: Manufacturer's standard device for securing grates to channel sections.
 - 4) Covers: Solid ductile or gray iron, of width and thickness that fit recesses in channels, and of lengths indicated.
 - 5) Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
 - 6) Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.
 - 7) ABT, Inc.
 - 8) ACO Polymer Products, Inc.
 - 9) Josam Company; Mea-Josam Div.
 - 10) Mifab.
 - 11) Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
- c. Type: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
- 1) Channel Sections: Narrow, interlocking-joint, sloped-invert, polymer-concrete modular units with end caps. Include rounded bottom, with built-in invert slope of 0.6 percent and with outlets in number, sizes, and locations indicated. Include extension sections necessary for required depth.
 - (a) Dimensions: 4-inch (102-mm) inside width. Include number of units required to form total lengths indicated.
 - (b) Frame: Gray-iron or galvanized steel for grates.
 - 2) Grates: Manufacturer's designation "heavy duty," with slots or perforations, and of width and thickness that fit recesses in channel sections.
 - (a) Material: Ductile iron.
 - (b) Locking Mechanism: Manufacturer's standard device for securing grates to channel sections.
 - 3) Covers: Solid ductile or gray iron, of width and thickness that fit recesses in channel sections, and of lengths indicated.
 - 4) Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
 - 5) Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.
 - 6) Channel Sections: Narrow, interlocking-joint, precast, polymer-concrete modular units with end caps. Include rounded bottom, with level invert and with NPS 4 (DN 100) outlets in number and locations indicated.
 - (a) Dimensions: 5-inch (127-mm) inside width and 9-3/4 inches (248 mm) deep. Include number of units required to form total lengths indicated.
 - (b) Frame: Gray-iron or galvanized steel for grates.
 - 7) Grates: Manufacturer's designation "heavy duty," with slots or perforations, and of width and thickness that fit recesses in channel sections.
 - (a) Material: Ductile iron.

- (b) Locking Mechanism: Manufacturer's standard device for securing grates to channel sections.
 - 8) Covers: Solid ductile or gray iron, of width and thickness that fit recesses in channel sections, and of lengths indicated.
 - 9) Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
 - 10) Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.
 - 11) Channel Sections: Wide, interlocking-joint, precast, polymer-concrete modular units with end caps. Include flat or rounded bottom, with level invert and with outlets in number, sizes, and locations indicated.
 - (a) Dimensions: 8-inch (203-mm) inside width and 13-3/4 inches (350 mm) deep. Include number of units required to form total lengths indicated.
 - (b) Frame: Gray-iron or galvanized steel for grates.
 - 12) Grates: Manufacturer's designation "heavy duty," with slots or perforations, and of width and thickness that fit recesses in channel sections.
 - (a) Material: Ductile iron.
 - (b) Locking Mechanism: Manufacturer's standard device for securing grates to channel sections.
 - 13) Covers: Solid ductile or gray iron, of width and thickness that fit recesses in channel sections, and of lengths indicated.
 - 14) Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
 - 15) Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.
 - 2. Polymer-Concrete Sediment Interceptor:
 - a. Description: 27-inch-square, precast, polymer-concrete body, with outlets in number and sizes indicated. Include 24-inch-square, gray-iron slotted grate.
 - b. Frame: Gray-iron or galvanized steel for grates.
- F. Air-Admittance Valves
- 1. Fixture Air-Admittance Valves:
 - 1) Oatey.
 - 2) Studor, Inc.
 - 3) Ayrlett, LLC.
 - 4) Durgo, Inc.
 - 5) ProSet Systems Inc.
 - 6) RectorSeal.
 - b. Housing: Plastic.
 - c. Operation: Mechanical sealing diaphragm.
 - d. Size: Same as connected fixture or branch vent piping.
2. Stack Air-Admittance Valves:
 - 1) Oatey.
 - 2) Studor, Inc.
 - 3) Durgo, Inc.
- b. Standard: ASSE 1050 for vent stacks.
- c. Housing: Plastic.
- d. Operation: Mechanical sealing diaphragm.
- e. Size: Same as connected stack vent or vent stack.
3. Wall Box:
 - 1) Oatey.
 - 2) Studor, Inc.
 - 3) Zurn Industries, LLC.

- 4) Durgo, Inc.
 - 5) RectorSeal.
 - b. Description: White plastic housing with white plastic grille, made for recessed installation. Include bottom pipe connection and space to contain one air-admittance valve.
 - c. Size: About 9 inches wide by 8 inches high by 4 inches deep.
- G. Roof Flashing Assemblies
 - 1. Roof Flashing Assemblies:
 - 1) Acorn Engineering Company.
 - 2) Thaler Metal Industries Ltd.
 - 3) Zurn Industries, LLC.
 - b. Description: Manufactured assembly made of 4.0 lb/sq. ft (20 kg/sq. m) , 0.0625 inch (1.6 mm) thick, lead flashing collar and skirt extending at least 6 inches (150 mm) from pipe, with galvanized-steel boot reinforcement and counterflashing fitting.
 - 1) Open-Top Vent Cap: Without cap.
 - 2) Low-Silhouette Vent Cap: With vandal-proof vent cap.
 - 3) Extended Vent Cap: With field-installed, vandal-proof vent cap.
- H. Flashing Materials
 - 1. Copper Sheet: ASTM B152/B152M, of the following minimum weights and thicknesses, unless otherwise indicated:
 - a. General Applications: 12 oz./sq. ft..
 - 2. Zinc-Coated Steel Sheet: ASTM A653/A653M, with 0.20 percent copper content and 0.04-inch minimum thickness, unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.
 - 3. Elastic Membrane Sheet: ASTM D4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.
 - 4. Fasteners: Metal compatible with material and substrate being fastened.
 - 5. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.
 - 6. Solder: ASTM B32, lead-free alloy.
 - 7. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.
- I. Through-Penetration Firestop Assemblies
 - 1. Through-Penetration Firestop Assemblies:
 - 1) ProSet Systems Inc.
 - b. Standard: ASTM E814, for through-penetration firestop assemblies.
 - c. Certification and Listing: Intertek Testing Service NA for through-penetration firestop assemblies.
 - d. Size: Same as connected soil, waste, or vent stack.
 - e. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
 - f. Stack Fitting: ASTM A48/A48M, gray-iron, hubless-pattern, wye branch with neoprene O-ring at base and gray-iron plug in thermal-release harness. Include PVC protective cap for plug.
 - g. Special Coating: Corrosion resistant on interior of fittings.
 - 1) Smith, Jay R. Mfg. Co.
 - (a) Josam Company.
 - (b) MIFAB, Inc.
 - (c) Smith, Jay R. Mfg. Co.
 - (d) Tyler Pipe.
 - (e) Watts Water Technologies, Inc.
 - (f) Zurn Plumbing Products Group; Specification Drainage Operation.

- (g) Applied Chemical Technology, Incorporated.
- (h) Rockford Sanitary Systems, Inc.
- (i) Schier Products Company.
- (j) Town & Country Plastics.
- (k) Zurn Plumbing Products Group.
- (l) Green Turtle.
- (m) Josam Company.
- (n) MIFAB, Inc.
- (o) Smith, Jay R. Mfg. Co.
- (p) Tyler Pipe.
- (q) Watts Water Technologies, Inc.
- (r) Zurn Plumbing Products Group; Specification Drainage Operation.
- (s) Applied Chemical Technology, Incorporated.
- (t) Rockford Sanitary Systems, Inc.
- (u) Striem (formerly Schier Products Company).
- (v) Town & Country Plastics, Inc.
- (w) Ashland Trap Distribution Co.
- (x) Green Turtle.
- (y) Josam Company.
- (z) MIFAB, Inc.
- (aa) Smith, Jay R. Mfg. Co.
- (bb) Tyler Pipe.
- (cc) Watts Water Technologies, Inc.
- (dd) Zurn Plumbing Products Group; Specification Drainage Operation.
- (ee) Rockford Sanitary Systems, Inc.
- (ff) Striem (formerly Schier Products Company).
- (gg) Town & Country Plastics, Inc.
- (hh) Green Turtle.

J. Motors

- 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

K. Miscellaneous sanitary drainage piping specialties

- 1. Open Drains:
 - a. Description: Shop or field fabricate from ASTM A74, Service class, hub-and-spigot, cast-iron, soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C564, rubber gaskets.
 - b. Size: Same as connected waste piping with increaser fitting of size indicated.
- 2. Deep-Seal Traps:
 - a. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
 - b. Size: Same as connected waste piping.
 - 1) NPS 2 (DN 50) : 4-inch- (100-mm-) minimum water seal.
 - 2) NPS 2-1/2 (DN 65) and Larger: 5-inch- (125-mm-)minimum water seal.
- 3. Floor-Drain, Trap-Seal Primer Fittings:
 - a. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
 - b. Size: Same as floor drain outlet with NPS 1/2 (DN 15) side inlet.
- 4. Air-Gap Fittings:
 - a. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
 - b. Body: Bronze or cast iron.

- c. Inlet: Opening in top of body.
 - d. Outlet: Larger than inlet.
 - e. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.
5. Sleeve Flashing Device:
- a. Description: Manufactured, cast-iron fitting, with clamping device, that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 1 inch (25 mm) above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
 - b. Size: As required for close fit to riser or stack piping.
6. Stack Flashing Fittings:
- a. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
 - b. Size: Same as connected stack vent or vent stack.
7. Vent Caps:
- a. Size: Same as connected stack vent or vent stack.
8. Frost-Resistant Vent Terminals:
- a. Description: Manufactured or shop-fabricated assembly constructed of copper, lead-coated copper, or galvanized steel.
 - b. Design: To provide 1-inch (25-mm) enclosed air space between outside of pipe and inside of flashing collar extension, with counterflashing.
9. Expansion Joints:
- a. Standard: ASME A112.21.2M.
 - b. Body: Cast iron with bronze sleeve, packing, and gland.
 - c. End Connections: Matching connected piping.
 - d. Size: Same as connected soil, waste, or vent piping.
 - 1) Josam Company.
 - 2) MIFAB, Inc.
 - 3) Smith, Jay R. Mfg. Co.
 - 4) Watts Water Technologies, Inc.
 - 5) Zurn Plumbing Products Group; Specification Drainage Operation.
 - 6) Oatey.
 - 7) Sioux Chief Manufacturing Company, Inc.
 - 8) Zurn Plumbing Products Group; Light Commercial Products Operation.
 - 9) IPS Corporation.
 - 10) Josam Company.
 - 11) MIFAB, Inc.
 - 12) Smith, Jay R. Mfg. Co.
 - 13) Tyler Pipe.
 - 14) Watts Water Technologies, Inc.
 - 15) Zurn Plumbing Products Group; Specification Drainage Operation.
 - (a) Josam Company.
 - 16) Josam Company.
 - 17) Smith, Jay R. Mfg. Co.
 - 18) Tyler Pipe.
 - 19) Watts Water Technologies, Inc.
 - 20) Zurn Plumbing Products Group; Specification Drainage Operation.
 - 21) Josam Company.
 - 22) Zurn Industries, LLC.
 - 23) Kusel Equipment Co.
 - 24) Josam Company.
 - 25) MIFAB, Inc.

- 26) Smith, Jay R. Mfg. Co.
- 27) Tyler Pipe.
- 28) Watts Water Technologies, Inc.
- 29) Jay R. Smith Mfg. Co.; a division of Morris Group International.
- 30) Tyler Pipe; a subsidiary of McWane Inc.
- 31) Watts Water Technologies; a Watts company.
- 32) Zurn Industries, LLC.
- 33) Josam Company.
- 34) MIFAB, Inc.
- 35) Smith, Jay R. Mfg. Co.
- 36) Tyler Pipe.
- 37) Watts Water Technologies, Inc.
- 38) Zurn Plumbing Products Group; Specification Drainage Operation.
 - (a) Jay R. Smith Mfg Co; a division of Morris Group International.
 - (b) Josam Company.
 - (c) Mifab.
 - (d) Watts Water Technologies; a Watts company.
 - (e) Zurn Industries, LLC.
 - (f) Jay R. Smith Mfg Co; a division of Morris Group International.
 - (g) Josam Company.
 - (h) Mifab.
 - (i) Watts Water Technologies; a Watts company.
 - (j) Zurn Industries, LLC.
 - (k) Jay R. Smith Mfg Co; a division of Morris Group International.
 - (l) Mifab.
 - (m) Watts Water Technologies; a Watts company.
 - (n) Zurn Industries, LLC.
 - (o) Jay R. Smith Mfg Co; a division of Morris Group International.
 - (p) Mifab.
 - (q) Watts Water Technologies; a Watts company.
 - (r) Zurn Industries, LLC.
 - (s) Jay R. Smith Mfg Co; a division of Morris Group International.
 - (t) Mifab.
 - (u) Watts Water Technologies; a Watts company.
 - (v) Zurn Industries, LLC.
 - (w) Jay R. Smith Mfg. Co; a division of Morris Group International.
 - (x) Thaler Metal Industries Ltd.
 - (y) Jay R. Smith Mfg. Co; a division of Morris Group International.
 - (z) Thaler Metal Industries Ltd.
 - (aa) Jay R. Smith Mfg Co; a division of Morris Group International.
 - (bb) Mifab.
 - (cc) Watts Water Technologies; a Watts company.
 - (dd) Zurn Industries, LLC.
 - (ee) Jay R. Smith Mfg Co; a division of Morris Group International.
 - (ff) Mifab.
 - (gg) Watts Water Technologies; a Watts company.
 - (hh) Zurn Industries, LLC.
 - (ii) Jay R. Smith Mfg Co; a division of Morris Group International.
 - (jj) Mifab,
 - (kk) Watts Water Technologies; a Watts company.
 - (ll) Zurn Industries, LLC.

- (mm) Jay R. Smith Mfg Co; a division of Morris Group International.
- (nn) Mifab.
- (oo) Wade; a subsidiary of McWane Inc
- (pp) Watts Water Technologies; a Watts company.
- (qq) Zurn Industries, LLC.
- (rr) Jay R. Smith Mfg Co; a division of Morris Group International.
- (ss) Mifab.
- (tt) Wade; a subsidiary of McWane Inc.
- (uu) Watts Water Technologies; a Watts company.
- (vv) Zurn Industries, LLC.
- (ww) Josam Company; Blucher-Josam Div.
- (xx) Mifab.
- (yy) Zurn Plumbing Products Group; Flo-Thru Operation.
- 39) ABT, Inc.
- 40) ACO Polymer Products, Inc.
- 41) Josam Company; Mea-Josam Div.
- 42) Mifab.
- 43) Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
- 44) Acorn Engineering Company.
- 45) Thaler Metal Industries Ltd.
- 46) Zurn Industries, LLC.
- 47) ProSet Systems Inc.
- 48) Jay R. Smith Mfg Co; a division of Morris Group International.
- 49) Wade; a subsidiary of McWane Inc.
- 50) Watts Water Technologies; a Watts company.
- 51) Zurn Industries, LLC.
- 52) Jay R. Smith Mfg Co; a division of Morris Group International.
- 53) Wade; a subsidiary of McWane Inc.
- 54) Watts Water Technologies; a Watts company.
- 55) Zurn Industries, LLC.
- 56) RectorSeal Plumbing; A CSW Industrials Company.
- 57) Jay R. Smith Mfg Co; a division of Morris Group International.
- 58) Wade; a subsidiary of McWane Inc.
- 59) Watts Water Technologies; a Watts company.
- 60) Zurn Industries, LLC.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Domestic Water Piping Specialties
 - 1. Refer to Section 22 10 05 - Plumbing Piping for piping joining materials, joint construction, and basic installation requirements.
 - 2. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
 - a. Locate backflow preventers in same room as connected equipment or system.
 - b. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe-to-floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are unacceptable for this application.
 - c. Do not install bypass piping around backflow preventers.

3. Install water regulators with inlet and outlet shutoff valves. Install pressure gages on inlet and outlet. When required, install water regulators in a 1/3 | 2/3 as the project requires.
4. Install water-control valves with inlet and outlet shutoff valves. Install pressure gages on inlet and outlet. When required, install water regulators in a 1/3 | 2/3 as the project requires.
5. Automatic Water Shutoff Valves: Test for signal strength before valve installation. Install automatic shutoff valve downstream from main domestic water shutoff valve. Install valve controller in an accessible location with sensors in areas where water is likely to accumulate.
6. Install balancing valves in locations where they can easily be accessed and adjusted.
7. Install potable water loop circulation system with Flow-Splitter in accordance with construction drawings and factory recommendations. Valve to be installed according to flow direction indicator.
 - a. Circulation loop piping from primary hot water source at the Flow-Splitter shall be run to connection points of angle stops serving fixtures and to tub or tub/shower points of connection returning to the Flow-Splitter/hot water source piping. Non-circulation portions of piping shall be no more than allowed by applicable energy code.
8. Install individual fixture temperature-actuated, water mixing valves on each lavatory/sink designated for hand washing.
9. Install temperature-actuated, water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.
 - a. Install thermometers and water regulators on inlets and outlets.
 - b. Install cabinet-type units recessed in or surface mounted on wall as specified.
10. Install Y-pattern strainers for water on supply side of each control valve, water pressure-reducing valve, solenoid valve, and pump.
11. Install outlet boxes recessed in wall or surface mounted on wall. Install 2-by-4-inch (38-by-89-mm) fire-retardant-treated-wood blocking, wall reinforcement between studs. Comply with requirements for fire-retardant-treated-wood blocking in Section "Rough Carpentry."
12. Install hose stations with check stops or shutoff valves on inlets and with thermometer on outlet.
 - a. Install cabinet-type units recessed in or surface mounted on wall as specified. Install 2-by-4-inch (38-by-89-mm) fire-retardant-treated-wood blocking, wall reinforcement between studs. Comply with requirements for fire-retardant-treated-wood blocking in Section "Rough Carpentry."
13. Install ground hydrants with 1 cu. yd. (0.75 cu. m) of crushed gravel around drain hole. Set ground hydrants with box flush with grade.
14. Install draining-type post hydrants with 1 cu. yd. (0.75 cu. m) of crushed gravel around drain hole. Set post hydrants in concrete paving or in 1 cu. ft. (0.03 cu. m) of concrete block at grade.
15. Set nonfreeze, nondraining-type post hydrants in concrete or pavement.
16. Set non-freeze sanitary yard hydrants with riser pipe in concrete or pavement. Do not encase canister in concrete.
17. Install water-hammer arresters in water piping according to PDI-WH 201.
18. Install air vents at all high points of water piping, including at the top of any rises/falls in horizontal piping. Install drain piping and discharge onto floor drain.
19. Install supply-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.
20. Install drainage-type, trap-seal primer valves as lavatory trap with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting.

21. Install trap-seal primer systems with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust system for proper flow.
- B. Sanitary Waste Piping Specialties
 1. Equipment Mounting: Install grease interceptors and solids interceptors on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases specified in Section 03 30 00 - Cast-in-Place Concrete.
 - a. Coordinate sizes and locations of concrete bases with actual equipment provided.
 - b. Construct bases to withstand, without damage to equipment, seismic force required by code.
 - c. Construct concrete bases 4 inches (100 mm) high and extend base not less than 6 inches (150 mm) in all directions beyond the maximum dimensions of FOG disposal systems, unless otherwise indicated or unless required for seismic anchor support.
 - d. Minimum Compressive Strength: 5000 psi (34.5 MPa) at 28 days.
 - e. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
 - f. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base, and anchor into structural concrete floor.
 - g. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - h. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - i. Comply with requirements for vibration isolation and seismic control devices specified in Section 20 05 48 - Vibration and Seismic Controls.
 2. Install backwater valves in building drain piping. For interior installation, provide cleanout deck plate flush with floor and centered over backwater valve cover, and of adequate size to remove valve cover for servicing.
 3. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
 4. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
 5. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
 - a. Position floor drains for easy access and maintenance.
 - b. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:
 - 1) Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
 - 2) Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
 - 3) Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.
 - c. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
 - d. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.
 6. Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface, unless otherwise indicated.
 7. Assemble and install ASME A112.3.1, stainless-steel channel drainage systems according to ASME A112.3.1. Install on support devices so that top will be flush with surface.
 8. Assemble non-ASME A112.3.1, stainless-steel channel drainage system components according to manufacturer's written instructions. Install on support devices so that top will be flush with adjacent surface.

9. Install fixture air-admittance valves on fixture drain piping.
10. Install stack air-admittance valves at top of stack vent and vent stack piping.
11. Install air-admittance-valve wall boxes recessed in wall.
12. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof. Comply with requirements in Division 07 Section "Sheet Metal Flashing and Trim."
13. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof. Comply with requirements in Division 07 Section "Sheet Metal Flashing and Trim."
14. Install through-penetration firestop assemblies in plastic {CH#136675} at floor penetrations. Comply with requirements in Division 07 Section "Penetration Firestopping."
15. Install deep-seal traps on floor drains and other waste outlets, if indicated.
16. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
 - a. Exception: Fitting may be omitted if trap has trap-seal primer connection.
 - b. Size: Same as floor drain inlet.
17. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.
18. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.
19. Install vent caps on each vent pipe passing through roof.
20. Install frost-resistant vent terminals on each vent pipe passing through roof. Maintain 1-inch (25-mm) clearance between vent pipe and roof substrate.
21. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.
22. Install frost-proof vent caps on each vent pipe passing through roof. Maintain 1-inch (25-mm) clearance between vent pipe and roof substrate.
23. Assemble components of FOG disposal systems and install on floor. Install trap, vent, fresh-air inlet, and flow-control fitting according to authorities having jurisdiction. Install shelf fastened to reinforcement in wall construction and adjacent to unit, unless otherwise indicated. Install culture bottle, culture metering pump, timer, and control on shelf. Install tubing between culture bottle, metering pump, and chamber.
24. Install grease interceptors, including trapping, venting, and flow-control fitting, according to authorities having jurisdiction and with clear space for servicing.
 - a. Above-Floor Installation: Set unit with bottom resting on floor, unless otherwise indicated.
 - b. Flush with Floor Installation: Set unit and extension, if required, with cover flush with finished floor.
 - c. Recessed Floor Installation: Set unit in receiver housing having bottom or cradle supports, with receiver housing cover flush with finished floor.
 - d. Install cleanout immediately downstream from interceptors not having integral cleanout on outlet.
25. Install grease removal devices on floor. Install trap, vent, and flow-control fitting according to authorities having jurisdiction. Install control panel adjacent to unit, unless otherwise indicated.
26. Install oil interceptors, including trapping, venting, and flow-control fitting, according to authorities having jurisdiction and with clear space for servicing. Coordinate oil-interceptor storage tank and gravity drain with Division 23 Section "Facility Fuel-Oil Piping."
27. Install solids interceptors with cleanout immediately downstream from interceptors that do not have integral cleanout on outlet. Install trap on interceptors that do not have integral trap and are connected to sanitary drainage and vent systems.
28. Install wood-blocking reinforcement for wall-mounting-type specialties.
29. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

30. Flashing Installation
- a. Comply with requirements in Division 07 Section "Sheet Metal Flashing and Trim."
 - b. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
 - 1) Lead Sheets: Burn joints of lead sheets 6.0-lb/sq. ft., 0.0938-inch thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft., 0.0625-inch thickness or thinner.
 - 2) Copper Sheets: Solder joints of copper sheets.
 - c. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
 - 1) Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches (250 mm), and skirt or flange extending at least 8 inches (200 mm) around pipe.
 - 2) Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches (200 mm) around sleeve.
 - 3) Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches (200 mm) around specialty.
 - d. Set flashing on floors and roofs in solid coating of bituminous cement.
 - e. Secure flashing into sleeve and specialty clamping ring or device.
 - f. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Division 07 Section "Sheet Metal Flashing and Trim."
 - g. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.
 - h. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.02 CONNECTIONS

- A. Domestic Water Piping Specialties
- B. Sanitary Waste Piping Specialties
 1. Comply with requirements in Division 22 Section 22 10 05 - Plumbing Piping for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.
 2. Install piping adjacent to equipment to allow service and maintenance.
 3. FOG Disposal Systems: Connect inlet and outlet to unit, connect flow-control fitting and fresh-air inlet piping to unit inlet piping, and connect vent piping between trap and media chamber. Connect electrical power.
 4. Grease Interceptors: Connect inlet and outlet to unit, and connect flow-control fitting and vent to unit inlet piping. Install valve on outlet of automatic drawoff-type unit.
 5. Grease Removal Devices: Connect controls, electrical power, factory-furnished accessories, and inlet, outlet, and vent piping to unit.
 6. Oil Interceptors: Connect inlet, outlet, vent, and gravity drawoff piping to unit; flow-control fitting and vent to unit inlet piping; and gravity drawoff and suction piping to oil storage tank.
 7. Ground equipment according to Division 26 Section 26 05 26 - Grounding and Bonding for Electrical Systems.
 8. Connect wiring according to Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.

3.03 FIELD QUALITY CONTROL

- A. Domestic Water Piping Specialties
 1. Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

2. Perform the following tests and inspections with the assistance of a factory-authorized service representative.
 - a. Test each pressure vacuum breaker according to authorities having jurisdiction and the device's reference standard.
 - b. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - c. Operational Test: After electrical circuitry has been energized, start units to confirm unit operation.
 - d. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 3. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.
 4. Prepare test and inspection reports.
- B. Sanitary Waste Piping Specialties
1. Perform tests and inspections and prepare test reports.
 - a. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled FOG and their installation, including piping and electrical connections, and to assist in testing.
 2. Tests and Inspections:
 - a. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - b. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Protection
1. Sanitary Waste Piping Specialties
 - a. Place plugs in ends of uncompleted piping at end of each day or when work stops.
 - b. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

3.04 IDENTIFICATION

- A. Domestic Water Piping Specialties
1. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
 - a. Pressure vacuum breakers.
 - b. Intermediate atmospheric-vent backflow preventers.
 - c. Reduced-pressure-principle backflow preventers.
 - d. Double-check, backflow-prevention assemblies.
 - e. Carbonated-beverage-machine backflow preventers.
 - f. Dual-check-valve backflow preventers.
 - g. Reduced-pressure-detector, fire-protection, backflow-preventer assemblies.
 - h. Double-check, detector-assembly backflow preventers.
 - i. Water pressure-reducing valves.
 - j. Calibrated balancing valves.
 - k. Primary, thermostatic, water mixing valves.
 - l. Manifold, thermostatic, water mixing-valve assemblies.
 - m. Photographic-process, thermostatic, water mixing-valve assemblies.
 - n. Primary water tempering valves.
 - o. Outlet boxes.
 - p. Hose stations.
 - q. Supply-type, trap-seal primer valves.
 - r. Trap-seal primer systems.

2. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 20 05 53 - Mechanical Identification.
- B. Sanitary Waste Piping Specialties
 1. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
 - a. FOG disposal systems.
 - b. Grease interceptors.
 - c. Solids interceptors.
 2. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 20 05 53 - Mechanical Identification.

3.05 ADJUSTING

- A. Domestic Water Piping Specialties
 1. Set field-adjustable pressure set points of water pressure-reducing valves.
 2. Set field-adjustable flow set points of balancing valves.
 3. Set field-adjustable temperature set points of temperature-actuated, water mixing valves.
 4. Adjust each pressure vacuum breaker in accordance with manufacturer's written instructions, authorities having jurisdiction and the device's reference standard.

3.06 DEMONSTRATION AND TRAINING

- A. Sanitary Waste Piping Specialties
 1. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain FOG disposal systems. Refer to Section 01 79 00 - Demonstration and Training.
 - a. Oil interceptors.

END OF SECTION

SECTION 22 34 00
FUEL-FIRED, DOMESTIC-WATER HEATERS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Commercial, Gas-Fired, Storage, Domestic-Water Heaters.
 - 1. Commercial, Power-Burner, Gas-Fired, Storage, Domestic-Water Heaters
 - 2. Commercial, Power-Vent, Gas-Fired, Storage, Domestic-Water Heaters
 - 3. Commercial, Gas-Fired, High-Efficiency, Storage, Domestic-Water Heaters
- B. Domestic-Water Heater Accessories.
- C. Venting Kits.

1.02 GENERAL REFERENCES

- A. Contract Documents: Refer to complete set of Contract Documents for requirements that are related to or may affect the work described in this Section.
- B. Division 20, including all Common Mechanical Requirements in Section 20 00 00, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.

1.03 REFERENCE STANDARDS

- A. ANSI Z21.10.3 - Gas-Fired Water Heaters, Volume III, Storage Water Heaters with Input Ratings Above 75,000 Btu per Hour, Circulating and Instantaneous; 2019 (Reaffirmed 2024).
- B. ANSI Z21.15/CSA 9.1-M - x; x.
- C. ANSI Z21.18/CSA 6.3 - Gas Appliance Pressure Regulators; 2019.
- D. ANSI Z21.20/CSA C22.2 - x; x.
- E. ANSI Z21.21 - x; x.
- F. ANSI Z21.22 - American National Standard for Relief Valves for Hot Water Supply Systems; 2015 (Reaffirmed 2020).
- G. ANSI/CSA LC 3 - x; x.
- H. ASCE/SEI 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures; 2016.
- I. ASHRAE Std 90.2 - High-Performance Energy Design of Residential Buildings; 2024, with Errata.
- J. ASHRAE Std 189.1 - Standard for the Design of High-Performance Green Buildings; 2020.
- K. ASME B1.20.1 - Pipe Threads, General Purpose, Inch; 2013 (Reaffirmed 2018).
- L. ASME B1.20.7 - Hose Coupling Screw Threads (Inch); 1991 (Reaffirmed 2024).
- M. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24 Metric/Inch Standard; 2025.
- N. ASME B16.24 - x; x.
- O. {RSTEMP#396}
- P. ASME BPVC-IV - Boiler and Pressure Vessel Code, Section IV - Rules for Construction of Heating Boilers; 2025, with Errata.
- Q. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1: Rules for Construction of Pressure Vessels; 2025, with Errata .
- R. ASSE 1005 - x; x.
- S. CSA 4.3 - x; x.

- T. ASTM A959 - Standard Guide for Specifying Harmonized Standard Grade Compositions for Wrought Stainless Steels; 2019.
- U. ANSI Z21.12 - x; x.
- V. IESNA 90.1 - Energy Standard for Sites and Buildings Except Low-Rise Residential Buildings; Approved Edition.
- W. NFPA 31 - Standard for the Installation of Oil-Burning Equipment; 2024.
- X. NFPA 54 - National Fuel Gas Code; 2024.
- Y. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- Z. NSF 5 - x; x.
- AA. UL 296 - x; x.
- BB. UL 732 - x; x.
- CC. NSF 61 - Drinking Water System Components - Health Effects; 2024.
- DD. UL 795 - Commercial-Industrial Gas Heating Equipment; Current Edition, Including All Revisions.

1.04 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Commercial domestic-water heaters shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.05 WARRANTIES

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of fuel-fired, domestic-water heaters that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including storage tank and supports.
 - b. Faulty operation of controls.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal use.
 - 2. Warranty Periods: From date of Substantial Completion.
 - a. Commercial, Gas-Fired, Storage, Domestic-Water Heaters:
 - 1) Storage Tank: Three years.
 - 2) Controls and Other Components: One year(s).
 - b. Expansion Tanks: Five year(s).

1.06 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE/IESNA Compliance: Fabricate and label fuel-fired, domestic-water heaters to comply with ASHRAE/IESNA 90.1.
 - 1. Comply with efficiency requirements in ASHRAE Std 189.1, which supersede requirements in ASHRAE/IESNA 90.1.
- C. ASME Compliance:
 - 1. Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME BPVC-VIII-1.
 - 2. Where ASME-code construction is indicated, fabricate and label commercial, finned-tube, domestic-water heaters to comply with ASME BPVC-IV.

- D. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61 Annex G, "Drinking Water System Components - Health Effects."

1.07 PRE-INSTALLATION TESTING

- A. Factory Tests: Test and inspect assembled domestic-water heaters and storage tanks specified to be ASME-code construction, according to {RS#396}.
- B. Hydrostatically test commercial domestic-water heaters and storage tanks to minimum of one and one-half times pressure rating before shipment.
- C. Domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Division 01 Section "Quality Requirements" for retesting and reinspecting requirements and Division 01 Section "Execution" for requirements for correcting the Work.
- D. Prepare test and inspection reports.

1.08 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2 PRODUCTS

2.01 COMMERCIAL, GAS-FIRED, STORAGE, DOMESTIC-WATER HEATERS

- A. Commercial, Power-Burner, Gas-Fired, Storage, Domestic-Water Heaters:
 - 1. Standard: ANSI Z21.10.3/CSA 4.3.
 - 2. Storage-Tank Construction: Non-ASME-code steel with 150-psig (1035 kPa) working-pressure rating.
 - a. Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing.
 - 1) NPS 2 (DN 50) and Smaller: Threaded ends according to ASME B1.20.1.
 - 2) NPS 2-1/2 (DN 65) and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges and according to ASME B16.24 for copper and copper-alloy flanges.
 - b. Interior Finish: Comply with NSF 61 Annex G barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
 - c. Lining: Cement complying with NSF 61 Annex G barrier materials for potable-water tank linings, including extending lining into and through tank fittings and outlets.
 - 3. Factory-Installed Storage-Tank Appurtenances:
 - a. Anode Rod: Replaceable magnesium.
 - b. Dip Tube: Required unless cold-water inlet is near bottom of tank.
 - c. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
 - d. Insulation: Comply with ASHRAE/IESNA 90.1. Surround entire storage tank except connections and controls.
 - e. Jacket: Steel with enameled finish.
 - f. Burner: UL 795 for power-burner, gas-fired, domestic-water heaters and natural-gas natural-gas fuel.
 - g. Automatic Ignition: ANSI Z21.20/CSA C22.2 No. 199, electric, automatic, gas-ignition system.
 - h. Temperature Control: Adjustable thermostat.
 - i. Safety Controls: Automatic, high-temperature-limit and low-water cutoff devices or systems.
 - j. Combination Temperature-and-Pressure Relief Valves: ANSI Z21.22/CSA 4.4-M. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.

4. Special Requirements: NSF 5 construction.
5. Draft Hood: Draft diverter, complying with ANSI Z21.12.
- B. Commercial, Power-Vent, Gas-Fired, Storage, Domestic-Water Heaters:
 1. Standard: ANSI Z21.10.3/CSA 4.3.
 2. Storage-Tank Construction: Non-ASME-code steel with 150-psig (1035-kPa) working-pressure rating.
 - a. Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing.
 - 1) NPS 2 (DN 50) and Smaller: Threaded ends according to ASME B1.20.1.
 - 2) NPS 2-1/2 (DN 65) and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges and according to ASME B16.24 for copper and copper-alloy flanges.
 - b. Interior Finish: Comply with NSF 61 Annex G barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
 - c. Lining: Cement complying with NSF 61 Annex G barrier materials for potable-water tank linings, including extending lining into and through tank fittings and outlets.
 3. Factory-Installed Storage-Tank Appurtenances:
 - a. Anode Rod: Replaceable magnesium.
 - b. Dip Tube: Required unless cold-water inlet is near bottom of tank.
 - c. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
 - d. Insulation: Comply with ASHRAE/IESNA 90.1. Surround entire storage tank except connections and controls.
 - e. Jacket: Steel with enameled finish.
 - f. Burner: For use with power-vent, gas-fired, domestic-water heaters and natural-gas fuel.
 - g. Automatic Ignition: ANSI Z21.20/CSA C22.2 No. 199, electric, automatic, gas-ignition system.
 - h. Temperature Control: Adjustable thermostat.
 - i. Safety Controls: Automatic, high-temperature-limit and low-water cutoff devices or systems.
 - j. Combination Temperature-and-Pressure Relief Valves: ANSI Z21.22/CSA 4.4-M. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.
 4. Special Requirements: NSF 5 construction.
 5. Power-Vent System: Exhaust fan, interlocked with burner.
- C. Commercial, Gas-Fired, High-Efficiency, Storage, Domestic-Water Heaters:
 1. Standard: ANSI Z21.10.3 /CSA 4.3.
 2. Description: Manufacturer's proprietary design to provide at least 85 percent combustion efficiency at optimum operating conditions.
 3. Storage-Tank Construction: Non-ASME-code steel with 150 psig (1035 kPa) minimum working-pressure rating.
 - a. Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing.
 - 1) NPS 2 (DN 50) and Smaller: Threaded ends according to ASME B1.20.1
 - 2) NPS 2-1/2 (DN 65) and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges and according to ASME B16.24 for copper and copper-alloy flanges.
 - b. Interior Finish: Comply with NSF 61 Annex G barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
 - c. Lining: Cement complying with NSF 61 Annex G barrier materials for potable-water tank linings, including extending lining into and through tank fittings and outlets.

4. Factory-Installed Storage-Tank Appurtenances:
 - a. Anode Rod: Replaceable magnesium.
 - b. Dip Tube: Required unless cold-water inlet is near bottom of tank.
 - c. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
 - d. Insulation: Comply with ASHRAE/IESNA 90.1. Surround entire storage tank except connections and controls.
 - e. Jacket: Steel with enameled finish.
 - f. Burner or Heat Exchanger: Comply with UL 795 or approved testing agency requirements for gas-fired, high-efficiency, domestic-water heaters and natural-gas natural-ga fuel.
 - g. Temperature Control: Adjustable thermostat.
 - h. Safety Controls: Automatic, high-temperature-limit and low-water cutoff devices or systems.
 - i. Combination Temperature-and-Pressure Relief Valves: ANSI Z21.22/CSA 4.4-M. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.
5. Draft Hood: Draft diverter, complying with ANSI Z21.12 .
6. Direct Vent/sealed combustion.

2.02 DOMESTIC-WATER HEATER ACCESSORIES

- A. Domestic-Water Expansion Tanks:
 1. Description: Steel, pressure-rated tank constructed with welded joints and factory-installed butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.
 2. Construction:
 - a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
 - b. Interior Finish: Comply with NSF 61 Annex G barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
 - c. Air-Charging Valve: Factory installed.
- B. Drain Pans: Corrosion-resistant metal with raised edge. Comply with ANSI/CSA LC 3. Include dimensions not less than base of domestic-water heater, and include drain outlet not less than NPS 3/4 (DN 20) with ASME B1.20.1 pipe threads or with ASME B1.20.7 garden-hose threads.
- C. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1 or ASHRAE Std 90.2.
- D. Heat-Trap Fittings: ASHRAE Std 90.2.
- E. Manifold Kits: Domestic-water heater manufacturer's factory-fabricated inlet and outlet piping for field installation, for multiple domestic-water heater installation. Include ball-, butterfly-, or gate-type shutoff valves to isolate each domestic-water heater and calibrated balancing valves to provide balanced flow through each domestic-water heater.
- F. Comply with requirements for ball-, butterfly-, or gate-type shutoff valves specified in Section 22 05 23 - General Duty Valves for Plumbing Piping.
- G. Comply with requirements for balancing valves specified in Section 22 10 06 - Plumbing Piping Specialties.
- H. Gas Shutoff Valves: ANSI Z21.15/CSA 9.1-M, manually operated. Furnish for installation in piping.
- I. Gas Pressure Regulators: ANSI Z21.18/CSA 6.3, appliance type. Include 1/2 psig pressure rating as required to match gas supply.

- J. Automatic Gas Valves: ANSI Z21.21/CSA 6.5, appliance, electrically operated, on-off automatic valve.
- K. Combination Temperature-and-Pressure Relief Valves: Include relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.
 - 1. Gas-Fired, Domestic-Water Heaters: ANSI Z21.22/CSA 4.4-M.
 - 2. Oil-Fired, Domestic-Water Heaters: ASME rated and stamped.
- L. Pressure Relief Valves: Include pressure setting less than domestic-water heater working-pressure rating.
 - 1. Gas-Fired, Domestic-Water Heaters: ANSI Z21.22/CSA 4.4-M.
 - 2. Oil-Fired, Domestic-Water Heaters: ASME rated and stamped.
- M. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4-M.
- N. Domestic-Water Heater Stands: Manufacturer's factory-fabricated steel stand for floor mounting, capable of supporting domestic-water heater and water. Provide dimension that will support bottom of domestic-water heater a minimum of 18 inches (457 mm) above the floor.
- O. Domestic-Water Heater Mounting Brackets: Manufacturer's factory-fabricated steel bracket for wall mounting, capable of supporting domestic-water heater and water.

2.03 VENTING KITS

- A. All venting material by Contractor: Refer to Section 23 51 00 - Breechings, Chimneys, and Stacks for requirements.
- B. Combustion-Air Intake: Complete system, CPVC pipe or material as specified in "Metal Ducts", vent terminal with screen, inlet air coupling, and sealant.
- C. Combustion-Air Intake: Complete system, stainless steel, pipe, vent terminal with screen, inlet air coupling, and sealant.
- D. Exhaust shall be AL29-4C stainless steel.
- E. Kit: Complete system, ASTM A959, Type AL29-4C stainless steel, pipe, vent terminal, thimble, indoor plate, vent adapter, condensate trap and dilution tank, and sealant.

PART 3 EXECUTION

3.01 INSTALLATION

- A. General
 - 1. Install domestic-water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
 - a. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Section 22 05 23 - General Duty Valves for Plumbing Piping.
 - 2. Install commercial domestic-water heaters with seismic-restraint devices. Comply with requirements for seismic-restraint devices specified in Section 20 05 48 - Vibration and Seismic Controls.
 - 3. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
 - 4. Install combination temperature-and-pressure relief valves in water piping for domestic-water heaters without storage. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

5. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for domestic-water heaters that do not have tank drains. Comply with requirements for hose-end drain valves specified in Section 22 10 06 - Plumbing Piping Specialties.
 6. Install thermometer on outlet piping of domestic-water heaters. Comply with requirements for thermometers specified in Section 20 05 19 - Meters and Gauges.
 7. Assemble and install inlet and outlet piping manifold kits for multiple domestic-water heaters. Fabricate, modify, or arrange manifolds for balanced water flow through each domestic-water heater. Include shutoff valve and thermometer in each domestic-water heater inlet and outlet, and throttling valve in each domestic-water heater outlet. Comply with requirements for valves specified in Section 22 05 23 - General Duty Valves for Plumbing Piping, and comply with requirements for thermometers specified in Section 20 05 19 - Meters and Gauges.
 8. Install piping-type heat traps on inlet and outlet piping of domestic-water heater storage tanks without integral or fitting-type heat traps.
 9. Fill domestic-water heaters with water.
 10. Charge domestic-water expansion tanks with air.
- B. Commercial, Domestic-Water Heater Mounting: Install commercial domestic-water heaters on concrete base. Comply with requirements for concrete base specified in Section 03 30 00 - Cast-in-Place Concrete.
1. Exception: Omit concrete bases for commercial domestic-water heaters if installation on stand, bracket, suspended platform, or directly on floor is indicated.
 2. Maintain manufacturer's recommended clearances.
 3. Arrange units so controls and devices that require servicing are accessible.
 4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18 inch (450 mm) centers around the full perimeter of concrete base.
 5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 6. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 7. Install anchor bolts to elevations required for proper attachment to supported equipment.
 8. Anchor domestic-water heaters to substrate.
- C. Install gas-fired, domestic-water heaters according to NFPA 54.
1. Install gas shutoff valves on gas supply piping to gas-fired, domestic-water heaters without shutoff valves.
 2. Install gas pressure regulators on gas supplies to gas-fired, domestic-water heaters without gas pressure regulators if gas pressure regulators are required to reduce gas pressure at burner.
 3. Install automatic gas valves on gas supplies to gas-fired, domestic-water heaters if required for operation of safety control.
 4. Comply with requirements for gas shutoff valves, gas pressure regulators, and automatic gas valves specified in Section 23 11 23 - Facility Natural-Gas Piping.
- D. Install oil-fired, domestic-water heaters according to NFPA 31.
1. Install shutoff valves on fuel-oil supply piping to oil-fired water-heater burners without shutoff valves. Comply with requirements for shutoff valves specified in Section 22 05 23 - General Duty Valves for Plumbing Piping.

3.02 CONNECTIONS

- A. Piping Connections
1. Where installing piping adjacent to fuel-fired, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

2. Comply with requirements for domestic-water piping specified in Section 22 10 05 - Plumbing Piping.
3. Comply with requirements for fuel-oil piping specified in Section 23 11 13 - Facility Fuel-Oil Piping.
4. Comply with requirements for gas piping specified in 23 11 23 - Facility Natural-Gas Piping.
5. Drawings indicate general arrangement of piping, fittings, and specialties.

3.03 FIELD TESTING

- A. Perform tests and inspections.
 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
 2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 01 40 00 - Quality Requirements for retesting and reinspecting requirements and Section 01 73 00 - Execution for requirements for correcting the Work.
- C. Prepare test and inspection reports, submit to Engineer and Project Address 2.

3.04 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification specified in Section 20 05 53 - Mechanical Identification.

3.05 DEMONSTRATION AND TRAINING

- A. Engage a factory-authorized service representative to train Project Address 2's maintenance personnel to adjust, operate, and maintain commercial, gas-fired, storage, and gas-fired, tankless domestic-water heaters.

END OF SECTION

**SECTION 22 42 00
COMMERCIAL PLUMBING FIXTURES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Wall-Mounted Water Closets.
- B. Water Closet Flushometer Valves.
- C. Toilet Seats.
- D. Wall-Hung Urinals.
- E. Urinal Flushometer Valves.
- F. Vitreous-China, Counter-Mounted Lavatories.
- G. Vitreous-China, Wall-Mounted Lavatories.
- H. Lavatories Systems.
- I. Solid-Brass, Automatically Operated Lavatory Faucets.
- J. Service Sinks.
- K. Sink Faucets.
- L. Laminar-Flow, Faucet-Spout Outlets.
- M. Supply Fittings.
- N. Waste Fittings.
- O. Supports.

1.02 GENERAL REFERENCES

1.03 RELATED REQUIREMENTS

- A. Section 22 41 00 - Residential Plumbing Fixtures for residential fixtures.
- B. Section 22 43 00 - Healthcare Plumbing Fixtures for healthcare fixtures.
- C. Section 22 46 00 - Security Plumbing Fixtures for security fixtures.

1.04 REFERENCE STANDARDS

1.05 DEFINITIONS

- A. Effective Flush Volume: Average of two reduced flushes and one full flush per fixture.
- B. Remote Water Closet: Located more than 30 feet (9.1 m) from other drain line connections or fixture and where less than 1.5 drainage fixture units are upstream of the drain line connection.
 - 1. Product Data: For each type of product.
 - a. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for lavatories.
 - b. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
 - 2. Product Data: For water consumption.
 - 3. Shop Drawings: Include diagrams for power, signal, and control wiring of automatic faucets.
 - 4. Plumbing Fixtures: Provide the following:
 - a. Manufacturer cut sheet indicating water consumption.
 - b. WaterSense certification for residential fixtures, commercial water closets, commercial urinals, and commercial showers.
 - 5. Coordination Drawings: Counter cutout templates for mounting of counter-mounted lavatories.

6. Operation and Maintenance Data: For flushometer valves, lavatories and faucets and electronic sensors to include in operation and maintenance manuals.
 - a. In addition to items specified in Section 01 78 23 - Operation and Maintenance Data, include the following:
 - 1) Servicing and adjustments of automatic faucets and flush valves.

1.06 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Faucet Washers and O-Rings: Equal to 10 percent of amount of each type and size installed.
 2. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.
 3. Flushometer-Valve Repair Kits: Equal to 10 percent of amount of each type installed, but no fewer than one of each type.
 4. Waterless Urinal Trap-Seal Cartridges: Equal to 200 percent of amount of each type installed, but no fewer than 12 of each type.
 5. Waterless Urinal Trap-Seal Liquid: Equal to 1 gal. (3.8 L) for each urinal installed.

PART 2 PRODUCTS

2.01 WALL-MOUNTED WATER CLOSETS

- A. Water Closets: Wall mounted, top spud.
 - a. American Standard.
 - b. Kohler Co.
 - c. Sloan.
 - d. TOTO USA, INC.
 - e. Zurn Industries, LLC; Commercial Brass and Fixtures.
2. Bowl:
 - a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
 - b. Material: Vitreous china.
 - c. Type: Siphon jet.
 - d. Style: Flushometer valve.
 - e. Height: Standard.
 - f. Rim Contour: Elongated.
 - g. Water Consumption: Refer to fixture schedule.
 - h. Spud Size and Location: NPS 1-1/2 (DN 40); top.
3. Flushometer Valve: See Drawings.
4. Support: Water closet carrier.
5. Water-Closet Mounting Height: See Drawings
- B. Water Closets: Wall mounted, back spud.
 - a. American Standard America.
 - b. Gerber Plumbing Fixtures LLC.
 - c. Kohler Co.
 - d. Sloan Valve Company.
 - e. TOTO USA, INC.
 - f. Zurn.
2. Bowl:
 - a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
 - b. Material: Vitreous china.
 - c. Type: Siphon jet.
 - d. Style: Flushometer valve.
 - e. Height: Standard.

- f. Rim Contour: Elongated.
- g. Water Consumption: See Drawings.
- h. Spud Size and Location: NPS 1-1/2 (DN 40); back.
- 3. Flushometer Valve: See Drawings.
- 4. Support: Water closet carrier.
- 5. Water-Closet Mounting Height: See Drawings.

2.02 WATER CLOSET FLUSHOMETER VALVES

A. Lever-Handle, Diaphragm Flushometer Valves:

- a. Coyne & Delany Co.
- b. Sloan Valve Company.
- c. Zurn Industries, LLC; Commercial Brass and Fixtures.
- 2. Standard: ASSE 1037.
- 3. Minimum Pressure Rating: 125 psig (860 kPa).
- 4. Features: Include integral check stop and backflow-prevention device.
- 5. Material: Brass body with corrosion-resistant components.
- 6. Exposed Flushometer-Valve Finish: Chrome plated.
- 7. Panel Finish: Chrome plated or stainless steel.
- 8. Style: Exposed.
- 9. Consumption: See Drawings.
- 10. Minimum Inlet: NPS 1 (DN 25).
- 11. Minimum Outlet: NPS 1-1/4 (DN 32).

B. Solenoid-Actuator, Diaphragm Flushometer Valves:

- a. Coyne & Delany Co.
- b. Sloan Valve Company.
- c. Zurn Industries, LLC; Commercial Brass and Fixtures.
- 2. Standard: ASSE 1037.
- 3. Minimum Pressure Rating: 125 psig (860 Kpa).
- 4. Features: Include integral check stop and backflow-prevention device.
- 5. Material: Brass body with corrosion-resistant components.
- 6. Exposed Flushometer-Valve Finish: Chrome plated.
- 7. Panel Finish: Chrome plated or stainless steel.
- 8. Style: Exposed
- 9. Actuator: Solenoid complying with UL 1951, and listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- 10. Trip Mechanism: Battery-powered electronic sensor complying with UL 1951, and listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- 11. Consumption: See Drawings.
- 12. Minimum Inlet: NPS 1 (DN 25).
- 13. Minimum Outlet: NPS 1-1/4 (DN 32).

C. Hydraulic-Actuator, Push-Button, Diaphragm Flushometer Valves:

- a. Coyne & Delany Co.
- b. Sloan Valve Company.
- c. Zurn.
- 2. Standard: ASSE 1037.
- 3. Minimum Pressure Rating: 125 psig (860 kPa).
- 4. Features: Include integral check stop and backflow-prevention device.
- 5. Material: Brass body with corrosion-resistant components.
- 6. Exposed Flushometer-Valve Finish: Chrome plated.
- 7. Panel Finish: Chrome plated or stainless steel.

8. Style: Exposed.
 9. Consumption: See Drawings.
 10. Minimum Inlet: NPS 1 (DN 25).
 11. Minimum Outlet: NPS 1-1/4 (DN 32).
- D. Lever-Handle, Piston Flushometer Valves:
- a. American Standard
 - b. Delany Products.
 - c. Kohler Co
 - d. Moen Incorporated.
 - e. Sloan Valve Company.
 - f. TOTO USA, INC.
 - g. Zurn Industries, LLC
2. Standard: ASSE 1037.
 3. Minimum Pressure Rating: 125 psig (860 kPa).
 4. Features: Include integral check stop and backflow-prevention device.
 5. Material: Brass body with corrosion-resistant components.
 6. Exposed Flushometer-Valve Finish: Chrome plated.
 7. Panel Finish: Chrome plated or stainless steel.
 8. Style: Exposed.
 9. Consumption: See Drawings.
 10. Minimum Inlet: NPS 1 (DN 25).
 11. Minimum Outlet: NPS 1-1/4 (DN 32).
- E. Hard-Wired, Solenoid-Actuator, Piston Flushometer Valves:
- a. American Standard
 - b. Delany Products.
 - c. Kohler Co
 - d. Moen Incorporated.
 - e. Sloan Valve Company.
 - f. TOTO USA, INC.
 - g. Zurn Industries, LLC
2. Standard: ASSE 1037.
 3. Minimum Pressure Rating: 125 psig (860 Kpa).
 4. Features: Include integral check stop and backflow-prevention device.
 5. Material: Brass body with corrosion-resistant components.
 6. Exposed Flushometer-Valve Finish: Chrome plated.
 7. Panel Finish: Chrome plated or stainless steel.
 8. Style: Exposed.
 9. Actuator: Solenoid complying with UL 1951, and listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 10. Trip Mechanism: Hard-wired electronic sensor complying with UL 1951, and listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 11. Consumption: See Drawings.
 12. Minimum Inlet: NPS 1 (DN 25).
 13. Minimum Outlet: NPS 1-1/4 (DN 32).
- F. Battery-Powered, Solenoid-Actuator, Piston Flushometer Valves:
- a. American Standard
 - b. Coyne & Delany Co.
 - c. Gerber Plumbing Fixtures LLC.
 - d. Kohler Co.
 - e. Moen Incorporated.

- f. Sloan Valve Company.
 - g. TOTO USA, INC.
 - h. Zurn Industries, LLC.
- 2. Standard: ASSE 1037.
- 3. Minimum Pressure Rating: 125 psig (860 kPa).
- 4. Features: Include integral check stop and backflow-prevention device.
- 5. Material: Brass body with corrosion-resistant components.
- 6. Exposed Flushometer-Valve Finish: Chrome plated.
- 7. Panel Finish: Chrome plated or stainless steel.
- 8. Style: Exposed.
- 9. Actuator: Solenoid complying with UL 1951, and listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- 10. Trip Mechanism: Battery-powered electronic sensor complying with UL 1951, and listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- 11. Consumption: See Drawings.
- 12. Minimum Inlet: NPS 1 (DN 25).
- 13. Minimum Outlet: NPS 1-1/4 (DN 32).

2.03 TOILET SEATS

A. Toilet Seats:

- a. American Standard America.
 - b. Bemis Manufacturing Company.
 - c. Church Seats.
 - d. Kohler Co.
 - e. Olsonite Seat Co.
 - f. TOTO USA, INC.
 - g. Zurn Industries, LLC; Commercial Brass and Fixtures.
- 2. Standard: IAPMO/ANSI Z124.5.
- 3. Material: Plastic.
- 4. Type: Commercial (heavy duty).
- 5. Shape: Elongated rim, open front.
- 6. Hinge: Self-sustaining, check.
- 7. Hinge Material: Noncorroding metal.
- 8. Seat Cover: See Drawings.

B. Toilet Seats (Child):

- a. Bemis Manufacturing Company.
 - b. Centoco Manufacturing Corporation.
 - c. Church Seats.
 - d. Kohler Co.
 - e. Olsonite Seat Co.
 - f. Sperzel of Lexington.
 - g. Zurn Industries, LLC; Commercial Brass and Fixtures.
- 2. Standard: IAPMO/ANSI Z124.5.
- 3. Material: Plastic.
- 4. Type: Commercial (heavy duty).
- 5. Shape: Elongated rim, open front.
- 6. Hinge: Self-sustaining check.
- 7. Hinge Material: Noncorroding metal.
- 8. Seat Cover: See Drawings.

2.04 WALL-HUNG URINALS

- A. Urinals: Wall hung, back outlet, siphon jet.
 - a. American Standard America.
 - b. Gerber Plumbing Fixtures LLC.
 - c. Kohler Co.
 - d. Mansfield Plumbing Products LLC.
- 2. Fixture:
 - a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
 - b. Material: Vitreous china.
 - c. Type: Siphon jet with extended shields.
 - d. Strainer or Trapway: Manufacturer's standard strainer with integral trap.
 - e. Water Consumption: See Drawings.
 - f. Spud Size and Location: NPS 3/4 (DN 20); back.
 - g. Outlet Size and Location: NPS 2 (DN 50); back.
- 3. Flushometer Valve: See Drawings.
- 4. Waste Fitting:
 - a. Standard: ASME A112.18.2/CSA B125.2 for coupling.
 - b. Size: NPS 2 (DN 50).
- 5. Support: ASME A112.6.1M, Type I, urinal carrier with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture. Include rectangular, steel uprights.
- 6. Urinal Mounting Height: Per architectural documents.

2.05 URINAL FLUSHOMETER VALVES

- A. Lever-Handle, Diaphragm Flushometer Valves:
 - a. American Standard.
 - b. Coyne & Delany Co.
 - c. Sloan Valve Company.
 - d. Zurn Industries, LLC; Commercial Brass and Fixtures.
- 2. Standard: ASSE 1037.
- 3. Minimum Pressure Rating: 125 psig (860 kPa).
- 4. Features: Include integral check stop and backflow-prevention device.
- 5. Material: Brass body with corrosion-resistant components.
- 6. Exposed Flushometer-Valve Finish: Chrome plated.
- 7. Panel Finish: Chrome plated or stainless steel.
- 8. Style: Exposed.
- 9. Consumption: See Drawings.
- 10. Minimum Inlet: NPS 3/4 (DN 20).
- 11. Minimum Outlet: NPS 3/4 (DN 20).
- B. Solenoid-Actuator, Diaphragm Flushometer Valves:
 - a. Coyne & Delany Co.
 - b. Sloan Valve Company.
 - c. Zurn Industries, LLC; Commercial Brass and Fixtures.
- 2. Standard: ASSE 1037.
- 3. Minimum Pressure Rating: 125 psig (860 KPa).
- 4. Features: Include integral check stop and backflow-prevention device.
- 5. Material: Brass body with corrosion-resistant components.
- 6. Exposed Flushometer-Valve Finish: Chrome plated.
- 7. Panel Finish: Chrome plated or stainless steel.
- 8. Style: Exposed.
- 9. Actuator: Solenoid complying with UL 1951; listed and labeled as defined in, NFPA 70 by a qualified testing agency; and marked for intended location and application.

10. Trip Mechanism: Battery-powered electronic sensor complying with UL 1951; listed and labeled as defined in NFPA 70, by a qualified testing agency; and marked for intended location and application.
 11. Consumption: See Drawings.
 12. Minimum Inlet: NPS 3/4 (DN 20).
 13. Minimum Outlet: NPS 3/4 (DN 20).
- C. Hydraulic-Actuator, Push-Button, Diaphragm Flushometer Valves:
- a. Coyne & Delany Co.
 - b. Sloan Valve Company.
 - c. Zurn.
 2. Standard: ASSE 1037.
 3. Minimum Pressure Rating: 125 psig (860 kPa).
 4. Features: Include integral check stop and backflow-prevention device.
 5. Material: Brass body with corrosion-resistant components.
 6. Exposed Flushometer-Valve Finish: Chrome plated.
 7. Panel Finish: Chrome plated or stainless steel.
 8. Style: Exposed.
 9. Consumption: See Drawings.
 10. Minimum Inlet: NPS 3/4 (DN 20).
 11. Minimum Outlet: NPS 3/4 (DN 20).
- D. Lever-Handle, Piston Flushometer Valves:
- a. American Standard, Inc.
 - b. Delany Products.
 - c. Kohler Co.
 - d. Moen Inc.
 - e. Sloan Valve Company.
 - f. TOTO USA, INC.
 - g. Zurn.
 2. Standard: ASSE 1037.
 3. Minimum Pressure Rating: 125 psig (860 kPa).
 4. Features: Include integral check stop and backflow-prevention device.
 5. Material: Brass body with corrosion-resistant components.
 6. Exposed Flushometer-Valve Finish: Chrome plated.
 7. Panel Finish: Chrome plated or stainless steel.
 8. Style: Exposed.
 9. Consumption: See Drawings.
 10. Minimum Inlet: NPS 3/4 (DN 20).
 11. Minimum Outlet: NPS 3/4 (DN 20).
- E. Hard-Wired, Solenoid-Actuator, Piston Flushometer Valves:
- a. Gerber Plumbing Fixtures LLC.
 - b. Moen Incorporated.
 - c. Sloan Valve Company.
 - d. TOTO USA, INC.
 2. Standard: ASSE 1037.
 3. Minimum Pressure Rating: 125 psig (860 kPa).
 4. Features: Include integral check stop and backflow-prevention device.
 5. Material: Brass body with corrosion-resistant components.
 6. Exposed Flushometer-Valve Finish: Chrome plated.
 7. Panel Finish: Chrome plated or stainless steel.
 8. Style: Exposed.

9. Actuator: Solenoid complying with UL 1951; listed and labeled as defined in NFPA 70, by a qualified testing agency; and marked for intended location and application.
 10. Trip Mechanism: Hard-wired electronic sensor complying with UL 1951; listed and labeled as defined in NFPA 70, by a qualified testing agency; and marked for intended location and application.
 11. Consumption: See Drawings.
- F. Battery-Powered, Solenoid-Actuator, Piston Flushometer Valves:
- a. Coyne & Delany Co.
 - b. Gerber Plumbing Fixtures LLC.
 - c. Kohler Co.
 - d. Moen Incorporated.
 - e. Sloan Valve Company.
 - f. TOTO USA, INC.
 - g. Zurn Industries, LLC; Commercial Brass and Fixtures.
2. Standard: ASSE 1037.
 3. Minimum Pressure Rating: 125 psig (860 kPa).
 4. Features: Include integral check stop and backflow-prevention device.
 5. Material: Brass body with corrosion-resistant components.
 6. Exposed Flushometer-Valve Finish: Chrome plated.
 7. Panel Finish: Chrome plated or stainless steel.
 8. Style: Exposed.
 9. Actuator: Solenoid complying with UL 1951 listed and labeled as defined in NFPA 70, by a qualified testing agency; and marked for intended location and application.
 10. Trip Mechanism: Battery-powered electronic sensor complying with UL 1951; listed and labeled as defined in NFPA 70, by a qualified testing agency; and marked for intended location and application.
 11. Consumption: See Drawings.
 12. Minimum Inlet: NPS 3/4 (DN 20).
 13. Minimum Outlet: NPS 3/4 (DN 20).

2.06 VITREOUS-CHINA, COUNTER-MOUNTED LAVATORIES

- A. Lavatory: Self Rimming, Rectangular, vitreous china, counter mounted.
1. Manufacturers:
 - a. American Standard America.
 - b. Gerber Plumbing Fixtures LLC.
 - c. Kohler Co.
 - d. TOTO USA, INC.
 - e. Sloan
 - f. Zurn Industries, LLC; Commercial Brass and Fixtures
 2. Fixture:
 - a. Standard: ASME A112.19.2/CSA B45.1.
 - b. Type: Self-rimming for above-counter mounting.
 - c. Faucet-Hole Punching: One hole.
 - d. Faucet-Hole Location: Top.
 - e. Mounting Material: Sealant.
 3. Faucet: See Drawings.
- B. Lavatory: Self Rimming, Oval or Round, vitreous china, counter mounted.
1. Manufacturers:
 - a. American Standard America.
 - b. Gerber Plumbing Fixtures LLC.
 - c. Kohler Co.

- d. Sloan.
- e. TOTO USA, INC.
- f. Zurn Industries, LLC; Commercial Brass and Fixtures.
- 2. Fixture:
 - a. Standard: ASME A112.19.2/CSA B45.1.
 - b. Type: Self-rimming for above-counter mounting.
 - c. Faucet-Hole Location: Top.
 - d. Mounting Material: Sealant.
- 3. Faucet: See Drawings.
- C. Lavatory: Rectangular, Oval, or Round, vitreous china, undercounter mounted.
 - a. American Standard America.
 - b. Gerber Plumbing Fixtures LLC.
 - c. Kohler Co.
 - d. Sloan Valve Company.
 - e. TOTO USA, INC.
 - f. Zurn Industries, LLC; Commercial Brass and Fixtures.
- 2. Fixture:
 - a. Standard: ASME A112.19.2/CSA B45.1.
 - b. Type: For undercounter mounting.
 - c. Faucet-Hole Punching: No holes.
 - d. Faucet-Hole Location: On countertop.
 - e. Mounting Material: Sealant and undercounter mounting kit.
- 3. Faucet: See Drawings.

2.07 VITREOUS-CHINA, WALL-MOUNTED LAVATORIES

- A. Lavatory: Vitreous china, wall mounted, with back.
 - a. American Standard America.
 - b. Gerber Plumbing Fixtures LLC.
 - c. Kohler Co.
 - d. Mansfield Plumbing Products LLC.
 - e. Sloan Valve Company.
 - f. Zurn Industries, LLC; Commercial Brass and Fixtures.
- 2. Fixture:
 - a. Standard: ASME A112.19.2/CSA B45.1.
 - b. Type: For wall hanging.
 - c. Faucet-Hole Location: Top
 - d. Mounting Material: Chair carrier.
- 3. Faucet: See Drawings.
- 4. Support: ASME A112.6.1M Type II, concealed-arm lavatory carrier with escutcheon. Include rectangular, steel uprights Type I, exposed-arm lavatory carrier.
- 5. Lavatory Mounting Height: See Architectural Drawings.
- B. Lavatory: Ledge back, vitreous china, wall mounted.
 - a. American Standard America.
 - b. Briggs Plumbing Products, Inc.
 - c. Ferguson Enterprises, Inc.; ProFlo Brand.
 - d. Gerber Plumbing Fixtures LLC.
 - e. Kohler Co.
 - f. Mansfield Plumbing Products LLC.
 - g. Peerless Pottery Sales, Inc.
 - h. Sloan Valve Company.
 - i. Zurn Industries, LLC; Commercial Brass and Fixtures.

2. Fixture:
 - a. Standard: ASME A112.19.2/CSA B45.1.
 - b. Type: For wall hanging.
 - c. Faucet-Hole Location: Top.
 - d. Mounting Material: Chair carrier.
 3. Faucet: Se.
 4. Support: Type II, concealed-arm lavatory carrier with escutcheons. Include rectangular, steel uprights.
 5. Lavatory Mounting Height: See Architectural Drawings.
- C. Lavatory: Slab type, vitreous china, wall mounted.
- a. American Standard America.
 - b. Kohler Co.
 - c. Sloan Valve Company.
 - d. Zurn Industries, LLC; Commercial Brass and Fixtures.
2. Fixture:
 - a. Standard: ASME A112.19.2/CSA B45.1.
 - b. Type: For wall hanging.
 - c. Faucet-Hole Location: Top.
 - d. Mounting Material: Chair carrier.
 3. Faucet: .
 4. Support: ASME A112.6.1M Type I, exposed-arm lavatory carrier,
 5. Lavatory Mounting Height: See Architectural Drawings.
- D. Lavatory: Wheelchair, vitreous china, wall mounted.
- a. American Standard America.
 - b. Kohler Co.
 - c. Mansfield Plumbing Products LLC.
 - d. Gerber Plumbing Fixtures LLC.
 - e. Sloan Valve Company.
2. Fixture:
 - a. Standard: ASME A112.19.2/CSA B45.1.
 - b. Type: Slab or wheelchair.
 - c. Faucet-Hole Location: Top.
 - d. Mounting: For concealed-arm carrier.
 3. Faucet: See Drawings.
 4. Support: ASME A112.6.1M, Type II, concealed-arm lavatory carrier with rectangular, steel uprights.
 5. Lavatory Mounting Height: See Architectural Drawings.
- E. Lavatory: Corner type, vitreous china, wall mounted.
- a. American Standard America.
 - b. Sloan Valve Company.
2. Fixture:
 - a. Standard: ASME A112.19.2/CSA B45.1.
 - b. Type: Three-sided-front apron with three-sided back.
 - c. Faucet-Hole Location: Back wall.
 - d. Mounting Materials: Wall brackets.
 3. Faucet: See Drawings.
 4. Support: ASME A112.6.1M, Type III, lavatory carrier with two hanger plates made for corner lavatories. Include rectangular, steel uprights.
 5. Lavatory Mounting Height: See Architectural Drawings.

2.08 LAVATORIES SYSTEMS

- A. Lavatory System - Single or Multiple Stations:
 - a. Bradley Commercial Products.
 - b. Sloan Valve Company.
 - c. Willoughby Manufacturing.
- 2. Standards: ASME A112.18.1/CSA B125.1, ANSI A117.1, CSA B45.5/IAPMO Z124, NSF 61, NSF 372, and UPC, IPC, and GREENGUARD Certified.
- 3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- 4. Bowl(s) and Counter:
 - a. Material: Solid-surface or natural quartz surface.
 - b. Height to Rim: See Architectural Drawings.
 - c. Access Panel: 16-1/8 inch (410 mm) access panel.
 - d. Mounting: Wall hung.
 - e. Number of Stations: One.
 - f. Drain: Grid with NPS 1-1/2 (DN 40) tailpiece, each bowl.
- 5. Pedestal: Not required.
- 6. Faucets:
 - a. Type: Manufacturer's standard, chrome-plated solid brass, each bowl.
 - b. Control: Manual, push-button, pressure-balancing mixing valve with check stops for each user station.
- 7. Mixer Point-of-Use:
 - a. Standards: ASSE 1070.
 - b. Material: Solid bimetal (bronze, brass, stainless steel).
 - c. Security: Hot limit stop set to a maximum of 109.4 deg F (43 deg C).
 - d. Operation: Electronic "no-touch" hardwired powered.
 - e. Power: 120 V ac.
- 8. High-Speed, Warm-Air Hand Dryer:
 - a. Dryer Mounting: Surface mounted, with low-profile design.
 - b. Operation: Electronic-sensor activated with operation time of 10 to 20 seconds.
 - c. Electrical Requirements: 115 V, 13 A, 1500 W.
- 9. Liquid-Soap Dispensers: Hardwired, sensor actuated, for each user station.
- 10. Lavatory System Mounting: Off floor on wall brackets and frame enclosure.
- 11. Supply Fittings:
 - a. Piping: NPS 1/2 (DN 15) copper tubing, each bowl.
 - b. Valves: Shutoff valve on each supply.
 - c. Supply Piping: From wall.
- 12. Waste Fittings:
 - a. Standard: ASME A112.18.2/CSA B125.2
 - b. Trap and Drain Piping: NPS 1-1/2 (DN 40), each bowl.

2.09 SOLID-BRASS, AUTOMATICALLY OPERATED LAVATORY FAUCETS

- A. Lavatory faucets intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act (SDWA), with requirements of the Authority Having Jurisdiction (AHJ), and with NSF 61/NSF 372, or be certified in compliance with NSF 61/NSF 372 by an American National Standards Institute (ANSI) accredited third-party certification body, that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.
- B. Lavatory Faucets: Automatic-type, battery-powered, electronic-sensor-operated, mixing.
 - a. American Standard America.
 - b. Bradley Corporation.
 - c. Chicago Faucets.
 - d. Kohler Co.

- e. Grohe America, Inc.
- f. Moen Incorporated.
- g. Sloan Valve Company.
- h. Speakman Company.
- i. T & S Brass and Bronze Works, Inc.
- j. TOTO USA, INC.
- k. Zurn Industries, LLC; Commercial Brass and Fixtures.
- 2. Standards: ASME A112.18.1/CSA B125.1 and UL 1951.
- 3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- 4. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and fixture receptor.
- 5. Body Material: Commercial, solid-brass, or die-cast housing with brazed copper and brass waterway.
 - a. Acorn Engineering Company.
 - b. Crane Plumbing, LLC.
 - c. Creative Industries.
 - d. Fiat Products.
 - e. Florestone Products Co., Inc.

2.10 SERVICE SINKS

- A. Service Sinks: Enameled, cast iron, trap standard mounted.
 - a. American Standard.
 - b. Commercial Enameling Company.
 - c. Kohler Co.
 - d. Zurn Industries.
- 2. Fixture:
 - a. Standard: ASME A112.19.1/CSA B45.2.
 - b. Type: Service sink with back.
 - c. Back: Two faucet holes.
 - d. Nominal Size: See Drawings.
 - e. Mounting: NPS 3 (DN 80) P-trap standard with grid strainer inlet, cleanout, and floor flange.
 - f. Rim Guard: On front and sides.
- 3. Faucet: See Drawings.
- 4. Support: Type II sink carrier.
- B. Service Sinks: Vitreous china, trap standard mounted.
 - a. American Standard.
 - b. Crane Plumbing, L.L.C
 - c. Kohler Co.
 - d. Zurn Industries, LLC; Commercial Brass and Fixtures.
- 2. Fixture:
 - a. Standard: ASME A112.19.2/CSA B45.1.
 - b. Type: Service sink with back.
 - c. Back: Two faucet holes.
 - d. Nominal Size: See Drawings.
 - e. Mounting: NPS 2 (DN 50) P-trap standard with grid strainer inlet, cleanout, and floor flange.
 - f. Rim Guard: On front and sides.
- 3. Faucet: See Drawings.
- 4. Support: Type II, sink carrier.

- C. Service Sinks: Enameled, cast iron, floor mounted.
 - a. American Standard America.
 - b. Commercial Enameling Company.
 - c. Kohler Co.
 - d. Zurn Industries, LLC; Commercial Brass and Fixtures.
- 2. Fixture:
 - a. Standard: ASME A112.19.1/CSA B45.2.
 - b. Style: With front apron and raised back.
 - c. Nominal Size: See Drawings.
 - d. Drain: Grid with NPS 3 (DN 80) NPS 3 outlet.
 - e. Rim Guard: Coated wire.
- 3. Faucet: See Drawings.

2.11 SINK FAUCETS

- A. NSF Standard: Comply with NSF 372 for faucet-spout materials that will be in contact with potable water.
- B. Sink Faucets: Manual type, single-control mixing valve.
 - 1. Commercial, Solid-Brass Faucets.
 - 1) American Standard America.
 - 2) Bradley Corporation.
 - 3) Chicago Faucets.
 - 4) Delta Faucet Company.
 - 5) Elkay Manufacturing Co.
 - 6) Grohe America, Inc.
 - 7) Just Manufacturing.
 - 8) Kohler Co.
 - 9) Moen Incorporated.
 - 10) Sloan Valve Company.
 - 11) Speakman Company.
 - 12) Symmons.
 - 13) T & S Brass and Bronze Works, Inc.
 - 14) Zurn Industries, LLC; Commercial Brass and Fixtures.
 - 2. Copper- or Brass-Underbody Faucets.
 - 1) American Standard America.
 - 2) Bradley Corporation.
 - 3) Chicago Faucets; Geberit Company.
 - 4) Delta Faucet Company.
 - 5) Elkay Manufacturing.
 - 6) GROHE America, Inc.
 - 7) Kohler Co.
 - 8) Moen Incorporated.
 - 9) Sloan Valve Company.
 - 10) Symmons.
 - 11) T&S Brass and Bronze Works, Inc.
 - 12) Zurn Industries.
 - 3. Standard: ASME A112.18.1/CSA B125.1
 - 4. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and sink receptor.
 - 5. Body Type: Centerset.
 - 6. Body Material: Commercial, solid brass.
 - 7. Maximum Flow Rate: 2.2 gpm (8.3 L/min.).

8. Handle(s): Lever.
 9. Mounting Type: Deck, concealed.
 10. Spout Type: Rigid, solid brass.
 11. Vacuum Breaker: Required for hose outlet.
 12. Spout Outlet: Aerator.
- C. Sink Faucets: Automatic-type, battery-powered, electronic-sensor-operated, mixing, solid-brass valve.
- a. American Standard.
 - b. Bradley Corporation.
 - c. Chicago Faucets; Geberit Company.
 - d. Delta Faucet Company.
 - e. Elkay Manufacturing Co.
 - f. GROHE America, Inc.
 - g. Kohler Co.
 - h. Moen Incorporated.
 - i. Sloan Valve Company.
 - j. Symmons Industries, Inc.
 - k. T&S Brass and Bronze Works, Inc.
 - l. Zurn Industries.
2. Standards: ASME A112.18.1/CSA B125.1 and UL 1951.
 3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 4. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and fixture receptor.
 5. Body Type: Single hole.
 6. Body Material: Commercial, solid brass.
 7. Maximum Flow Rate: See Drawings.
 8. Mounting Type: Deck, concealed.
 9. Spout Outlet: Aerator.

2.12 LAMINAR-FLOW, FAUCET-SPOUT OUTLETS

- A. NSF Standard: Comply with NSF 372 for faucet-spout-outlet materials that will be in contact with potable water.
1. AM Conservation Group, Inc.
 2. Chronomite Laboratories, Inc.
 3. NEOPERL, Inc.
- B. Description: Chrome-plated-brass, faucet-spout outlet that produces non-aerating, laminar stream. Include external or internal thread that mates with faucet outlet for attachment to faucets where indicated and flow-rate range that includes flow of faucet.

2.13 SUPPLY FITTINGS

- A. NSF Standard: Comply with NSF 372 for supply-fitting materials that will be in contact with potable water.
- B. Standard: ASME A112.18.1/CSA B125.1
- C. Supply Piping: Chrome-plated-brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated-brass or stainless-steel wall flange.
- D. Supply Stops: Chrome-plated-brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.
- E. Operation: Loose key.
- F. Risers:

1. Refer to fixture schedule for sizes.
2. Chrome-plated, soft-copper flexible tube.

2.14 WASTE FITTINGS

- A. Standard: ASME A112.18.2/CSA B125.2.
- B. Lavatory:
 1. Drain: Grid type with NPS 1-1/4 (DN 32) offset and straight tailpiece.
 2. Trap:
 - a. Size: NPS 1-1/2 by NPS 1-1/4 (DN 40 by DN 32) unless otherwise scheduled.
 - b. Material: Chrome-plated, two-piece, cast-brass trap and swivel elbow with 0.032-inch (0.83-mm) thick brass tube to wall; and chrome-plated, brass or steel wall flange.
 - c. Material: Stainless-steel, two-piece trap and swivel elbow with 0.012 inch (0.30 mm) thick stainless-steel tube to wall; and stainless-steel wall flange.
- C. Sink:
 1. Drain: Grid type with NPS 1-1/2 (DN 40) offset and straight tailpiece.
 2. Trap:
 - a. Size: NPS 1-1/2 (DN 40) unless otherwise scheduled.
 - b. Material: Chrome-plated, two-piece, cast-brass trap and swivel elbow with 0.032-inch (0.83-mm) thick brass tube to wall; and chrome-plated brass or steel wall flange.
 - c. Material: Stainless-steel, two-piece trap and swivel elbow with 0.012 inch (0.30 mm) thick stainless-steel tube to wall; and stainless-steel wall flange.

2.15 SUPPORTS

- A. Water Closet Carrier:
 1. Manufacturers:
 - a. Jay R. Smith Mfg. Co.
 - b. Josam Company.
 - c. Mifab.
 - d. Wade Drains.
 - e. WATTS.
 - f. Zurn Industries, Inc.
 2. Standard: ASME A112.6.1M.
 3. Description: Waste-fitting assembly, as required to match drainage piping material and arrangement with faceplates, couplings gaskets, and feet; bolts and hardware matching fixture. Include additional extension coupling, faceplate, and feet for installation in wide pipe space.
- B. Type I Urinal Carrier:
 1. Manufacturers:
 - a. Jay R. Smith Mfg. Co.
 - b. Josam Company.
 - c. MIFAB, Inc.
 - d. Wade Drains.
 - e. Watts; a Watts Water Technologies company.
 - f. Zurn Industries, LLC.
 2. Standard: ASME A112.6.1M.
- C. Type II Urinal Carrier:
 - a. Jay R. Smith Mfg. Co.
 - b. Josam Company.
 - c. MIFAB, Inc.
 - d. Wade Drains.
 - e. Watts; a Watts Water Technologies company.

- f. Zurn Industries, LLC.
 - 2. Standard: ASME A112.6.1M.
- D. Type II Lavatory Carrier:
 - a. Jay R. Smith Mfg. Co.
 - b. Josam Company.
 - c. MIFAB, Inc.
 - d. Wade Drains.
 - e. Watts; a Watts Water Technologies company.
 - f. Zurn Industries, LLC.
- 2. Standard: ASME A112.6.1M.
- E. Type III Lavatory Carrier:
 - 1. Manufacturers:
 - a. Jay R. Smith Mfg. Co.
 - b. Josam Company.
 - c. MIFAB, Inc.
 - d. Wade Drains.
 - e. Watts; a Watts Water Technologies company.
 - f. Zurn Industries, LLC.
 - 2. Standard: ASME A112.6.1M.
- F. Type I Sink Carrier:
 - 1. Manufacturers:
 - a. Jay R. Smith Mfg. Co.
 - b. Josam Company.
 - c. MIFAB, Inc.
 - d. Wade Drains.
 - e. Watts; a Watts Water Technologies company.
 - f. Zurn Industries, LLC.
 - 2. Standard: ASME A112.6.1M.
- G. Type II Sink Carrier:
 - 1. Manufacturers:
 - a. Jay R. Smith Mfg. Co.
 - b. Josam Company.
 - c. MIFAB, Inc.
 - d. Wade Drains.
 - e. Watts; a Watts Water Technologies company.
 - f. Zurn Industries, LLC.
 - 2. Standard: ASME A112.6.1M.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before fixture installation.
- B. Examine counters, walls, and floors for suitable conditions where fixtures will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Water-Closet Installation:
 - 1. Install level and plumb according to roughing-in drawings.
 - 2. Install floor-mounted water closets on bowl-to-drain connecting fitting attachments to piping or building substrate.

3. Install accessible, wall-mounted water closets at mounting height for handicapped/elderly, according to ANSI/ICC A117.1.
 4. Support Installation:
 - a. Install supports, affixed to building substrate, for floor-mounted, back-outlet water closets.
 - b. Use carrier supports with waste-fitting assembly and seal.
 - c. Install floor-mounted, back-outlet water closets attached to building floor substrate, onto waste-fitting seals; and attach to support.
 - d. Install wall-mounted, back-outlet water-closet supports with waste-fitting assembly and waste-fitting seals; and affix to building substrate.
 5. Flushometer-Valve Installation:
 - a. Install flushometer-valve, water-supply fitting on each supply to each water closet.
 - b. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
 - c. Install lever-handle flushometer valves for accessible water closets with handle mounted on open side of water closet.
 - d. Install actuators in locations that are easy for people with disabilities to reach.
 - e. Install fresh batteries in battery-powered, electronic-sensor mechanisms.
 6. Install toilet seats on water closets.
 7. Wall Flange and Escutcheon Installation:
 - a. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations and within cabinets and millwork.
 - b. Install deep-pattern escutcheons if required to conceal protruding fittings.
 - c. Comply with escutcheon requirements specified in Section 20 05 00 - Common Mechanical Work Results.
 8. Joint Sealing:
 - a. Seal joints between water closets and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
 - b. Match sealant color to water-closet color.
 - c. Comply with sealant requirements specified in Division 07 Section "Joint Sealants."
- B. Urinal Installation:
1. Install urinals level and plumb according to roughing-in drawings.
 2. Install wall-hung, back-outlet urinals onto waste fitting seals and attached to supports.
 3. Install wall-hung, bottom-outlet urinals with tubular waste piping attached to supports.
 4. Install accessible, wall-mounted urinals at mounting height for the handicapped/elderly, according to ANSI/ICC A117.1.
 5. Install trap-seal liquid in waterless urinals.
 6. Support Installation:
 - a. Install supports, affixed to building substrate, for wall-hung urinals.
 - b. Use off-floor carriers with waste fitting and seal for back-outlet urinals.
 - c. Use carriers without waste fitting for urinals with tubular waste piping.
 - d. Use chair-type carrier supports with rectangular steel uprights for accessible urinals.
 7. Flushometer-Valve Installation:
 - a. Install flushometer-valve water-supply fitting on each supply to each urinal.
 - b. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
 - c. Install lever-handle flushometer valves for accessible urinals with handle mounted on open side of compartment.
 - d. Install fresh batteries in battery-powered, electronic-sensor mechanisms.
 8. Wall Flange and Escutcheon Installation:
 - a. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations.
 - b. Install deep-pattern escutcheons if required to conceal protruding fittings.

- c. Comply with escutcheon requirements specified in Section 20 05 00 - Common Mechanical Work Results.
- 9. Joint Sealing:
 - a. Seal joints between urinals and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
 - b. Match sealant color to urinal color.
 - c. Comply with sealant requirements specified in Division 07 Section "Joint Sealants."
- C. Lavatory Installation:
 - 1. Install lavatories level and plumb according to roughing-in drawings.
 - 2. Install supports, affixed to building substrate, for wall-mounted lavatories.
 - 3. Install accessible wall-mounted lavatories at handicapped/elderly mounting height for people with disabilities or the elderly, according to ANSI/ICC A117.1.
 - 4. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 20 05 00 - Common Mechanical Work Results.
 - 5. Seal joints between lavatories, counters, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Division 07 Section "Joint Sealants."
 - 6. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories. Comply with requirements in Section 20 07 00 - Mechanical Insulation.
- D. Sink Installation:
 - 1. Install sinks level and plumb according to roughing-in drawings.
 - 2. Install supports, affixed to building substrate, for wall-hung sinks.
 - 3. Install accessible wall-mounted sinks at handicapped/elderly mounting height according to ANSI/ICC A117.1.
 - 4. Set floor-mounted sinks in leveling bed of cement grout.
 - 5. Install water-supply piping with stop on each supply to each sink faucet.
 - a. Exception: Use ball, gate, or globe valves if supply stops are not specified with sink. Comply with valve requirements specified in Section 22 05 23 - General Duty Valves for Plumbing Piping.
 - b. Install stops in locations where they can be easily reached for operation.
 - 6. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 20 05 00 - Common Mechanical Work Results.
 - 7. Seal joints between sinks and counters, floors, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Division 07 Section "Joint Sealants."
 - 8. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible sinks. Comply with requirements in Section 20 07 00 - Mechanical Insulation.

3.03 CONNECTIONS

- A. Piping Connections
 - 1. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
 - 2. Where installing piping adjacent to fixtures, allow space for service and maintenance.
 - 3. Comply with water piping requirements specified in Section 22 10 05 - Plumbing Piping "Plumbing Piping."
- B. Electrical Connections for Fixtures and Transformers

1. Connect wiring according to Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.
2. Ground equipment according to Section 26 05 26 - Grounding and Bonding for Electrical Systems.
3. Install electrical devices furnished by manufacturer, but not factory mounted in accordance with NFPA 70 and NECA 1.
4. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
 - a. Nameplate to be laminated acrylic or melamine plastic signs, as specified in Section 26 05 53 - Identification for Electrical Systems.

3.04 ADJUSTING

- A. Operate and adjust fixtures and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.
- B. Adjust water pressure at faucets, flushometer valves, shower heads, etc. to produce proper flow.
- C. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

3.05 CLEANING

- A. After completing installation of fixtures, inspect fixtures for damaged finishes. Replace any fixture damaged during construction.
- B. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.
- C. Provide protective covering for installed fixtures and fittings.
- D. Do not allow use of fixtures for temporary facilities unless approved in writing by Project Address 2.

END OF SECTION

**SECTION 22 47 00
DRINKING FOUNTAINS & ELECTRIC WATER COOLERS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Drinking Fountains.
 - 1. Stainless steel, wall mounted, semi-recessed
- B. Fixture Supports.
 - 1. Type I Water Cooler Carrier
 - 2. Type II Water Cooler Carrier

1.02 GENERAL REFERENCES

- A. Contract Documents: Refer to complete set of Contract Documents for requirements that are related to or may affect the work described in this Section.
- B. Division 20, including all Common Mechanical Requirements in Section 20 00 00, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.

1.03 REFERENCE STANDARDS

- 1. Product Data: For each type of drinking fountain.
 - a. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
 - b. Include operating characteristics, and furnished specialties and accessories.
- 2. Maintenance Data: For drinking fountains to include in maintenance manuals.

1.04 QUALITY ASSURANCE

- A. Drinking Water System Components - Health Effects and Drinking Water System Components - Lead Content Compliance: NSF 61 and NSF 372 for all components that will be in contact with potable water.

PART 2 PRODUCTS

2.01 DRINKING FOUNTAINS

- A. Drinking Fountains: Stainless steel, wall mounted, semi-recessed.
 - 1. Stainless-Steel Drinking Fountains:
 - a. Manufacturers:
 - 1) Elkay Manufacturing Co.
 - 2) Filtrine Manufacturing Company.
 - 3) Halsey Taylor.
 - 4) Haws Corporation.
 - 5) Oasis International; a Lynn Tilton company.
 - 2. Standards: Comply with ASME A112.19.3 /CSA B45.4.
 - 3. Standards: Comply with NSF 61 Annex G.
 - 4. Receptor Shape: Concave with projecting bowl.
 - 5. Bubbler: One, with adjustable stream regulator, located on deck.
 - 6. Maximum water flow: 0.15 gpm.
 - 7. Control: Push button.
 - 8. Drain: Grid type with NPS 1-1/4 (DN 32) tailpiece.
 - 9. Supply: NPS 3/8 (DN 10) ith shutoff valve.
 - 10. Waste Fitting: ASME A112.18.2 /CSA B125.2, NPS 1-1/4 (DN 32) brass P-trap.
 - 11. Support: Mounting frame or brackets for attaching to wood blocking or substrate.
 - 12. Drinking Fountains: Stainless steel, recessed.

- a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Elkay Manufacturing Co.
 - 2) Filtrine Manufacturing Company.
 - 3) Halsey Taylor.
 - 4) Haws Corporation.
 - 5) Oasis International; a Lynn Tilton company.
- 13. Standards: Comply with NSF 61 Annex G.
- 14. Receptor Shape: Concave with flush wall flange.
- 15. Bubbler: One, with adjustable stream regulator, located on deck.
- 16. Control: Push button.
- 17. Drain: Grid type with NPS 1-1/4 (DN 32) minimum horizontal waste and trap, complying with ASME A112.18.2/CSA B125.2.
- 18. Supply: NPS 3/8 (DN 10) with shutoff valve.
- 19. Support: Mounting frame or brackets for attaching to wood blocking or substrate.
 - a. Oasis International; a Lynn Tilton company.

2.02 FIXTURE SUPPORTS

- A. Type I Water Cooler Carrier:
 - a. Jay R. Smith Mfg. Co.
 - b. Josam Company.
 - c. Wade Drains.
 - d. WATTS.
 - e. Zurn Industries, Inc.
- 2. Standard: ASME A112.6.1M.
- B. Type II Water Cooler Carrier:
 - a. Jay R. Smith Mfg. Co.
 - b. Josam Company.
 - c. Wade Drains.
 - d. WATTS.
 - e. Zurn Industries, Inc.
- 2. Standard: ASME A112.6.1M.

PART 3 EXECUTION

3.01 APPLICATION

- A. Use carrier off-floor supports for wall-mounting fixtures, unless otherwise indicated.
- B. Use mounting frames for recessed water coolers, unless otherwise indicated.
- C. Use chrome-plated brass or copper tube, fittings, and valves in locations exposed to view. Plain copper tube, fittings, and valves may be used in concealed locations.

3.02 EXAMINATION

- A. Examine roughing-in for water-supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before fixture installation.
- B. Examine walls and floors for suitable conditions where fixtures will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.03 INSTALLATION

- A. Install off-floor supports affixed to building substrate and attach wall-mounting fixtures, unless otherwise indicated.
- B. Install mounting frames affixed to building construction and attach recessed water coolers to mounting frames, unless otherwise indicated.

- C. Install fixtures level and plumb according to roughing-in drawings. For fixtures indicated for children, install at height required by authorities having jurisdiction.
- D. Set freestanding and pedestal drinking fountains on floor.
- E. Install recessed drinking fountains secured to wood blocking in wall construction.
- F. Install remote water coolers level and plumb according to roughing-in drawings.
- G. Set remote water coolers on floor unless otherwise indicated.
- H. Install off-the-floor carrier supports, affixed to building substrate, for wall-mounted fixtures.
- I. Install water-supply piping with shutoff valve on supply to each fixture to be connected to domestic-water distribution piping. Use ball, gate, or globe valve. Install valves in locations where they can be easily reached for operation.
- J. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.
- K. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding fittings.
- L. Seal joints between fixtures and walls using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Sealants are specified in Section 07 92 00 - Joint Sealants.

3.04 CONNECTIONS

- A. Piping Connections
 - 1. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
 - 2. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
 - 3. Ground equipment according to Section 26 05 26 - Grounding and Bonding for Electrical Systems.
 - 4. Connect wiring according to Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.
 - 5. Comply with water piping requirements specified in Section 22 10 05 - Plumbing Piping.
 - 6. Install ball shutoff valve on water supply to each device. Install valve upstream from filter for water cooler. Comply with valve requirements specified in Section 22 05 23 - General Duty Valves for Plumbing Piping.
 - 7. Comply with soil and waste piping requirements specified in Section 22 10 05 - Plumbing Piping.

3.05 FIELD QUALITY CONTROL

- A. Water Cooler Testing: After electrical circuitry has been energized, test for compliance with requirements. Test and adjust controls and safeties.
 - 1. Remove and replace malfunctioning units and retest as specified above.
 - 2. Report test results in writing.

3.06 ADJUSTING

- A. Adjust fixture flow regulators for proper flow and stream height.
- B. Adjust pressure water-cooler temperature settings.

3.07 CLEANING

- A. After installing fixtures, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.
- B. Clean fixtures, on completion of installation, according to manufacturer's written instructions.
- C. Provide protective covering for installed fixtures.

- D. Do not allow use of fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION

SECTION 23 01 30.51
HVAC AIR-DISTRIBUTION SYSTEM CLEANING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Cleaning of HVAC duct system, equipment, and related components.
- B. Testing and inspection agency employed by Owner or General Contractor.

1.02 QUALIFICATION OF THE HVAC SYSTEM CLEANING CONTRACTOR

- A. Membership: The HVAC system cleaning contractor shall be a certified member of the National Air Duct Cleaners Association (NADCA), or shall maintain membership in a nationally recognized non-profit industry organization dedicated to the cleaning of HVAC systems.
- B. Certification: The HVAC system cleaning contractor shall have a minimum of one (1) Air System Cleaning Specialist (ASCS) certified by NADCA on a full time basis, or shall have staff certified by a nationally recognized certification program and organization dedicated to the cleaning of HVAC systems.
- C. Supervisor Qualifications: A person certified as an ASCS by NADCA, or maintaining an equivalent certification by a nationally recognized program and organization, shall be responsible for the total work herein specified.
- D. Experience: The HVAC system cleaning contractor shall submit records of experience in the field of HVAC system cleaning.
- E. Equipment, Material, and Labor: The HVAC system cleaning contractor shall possess and furnish all necessary equipment, materials and labor to adequately perform the specified services.
 - 1. The contractor shall assure that its employees have received safety equipment training, medical surveillance program, individual health protection measures, and manufacturer's product and material safety data sheets (MSDS) as required for the work by the U.S. Occupational Safety and Health Administration, and as described by its specification.
 - 2. The contractor shall maintain a copy of all current MSDS documentation and safety certifications at the site at all times, as well as comply with all other site documentation requirements of applicable OSHA programs and this specification.
 - 3. Contractor shall submit all Material Safety Data Sheet (MSDS) for all chemical products proposed to be used in the cleaning process.
- F. Licensing: The HVAC system cleaning contractor shall provide proof of maintaining the proper license(s), if any, as required to do work in the State of this project. The Contractor shall comply with all Federal, State, and Local rules, regulations, and licensing requirements.

1.03 SCOPE OF WORK

- A. Scope: This section defines the minimum requirements necessary to render HVAC components clean, and to verify the cleanliness through inspection and/or testing in accordance with items specified herein and applicable NADCA Standards.
- B. The Contractor shall be responsible for the removal of visible surface contaminants and deposits from within the HVAC system in strict accordance with these specifications.
- C. The HVAC system includes any interior surface of the facility's air distribution system containing internally lined ductwork as indicated in the contract documents and as built drawings. This includes ducts from the points where the air enters the system to the points where the air is discharged from the system. The supply air ducts, turning vanes, and supply diffusers.
- D. Coat all internally lined ductwork with a biocidal growth inhibitor.
- E. Encapsulate all internally lined ductwork with a water based protective coating to seal all surfaces.

- F. Repair or replace any missing or degraded insulation.
- G. Section 01 57 19 - Temporary Environmental Controls.

1.04 DEFINITIONS

- A. HVAC System: For purposes of this section, the surfaces to be cleaned include all interior surfaces of the heating, air-conditioning and ventilation system from the points where the air enters the system to the points where the air is discharged from the system, including the inside of air distribution equipment, coils, and condensate drain pans; see NADCA ACR for more details.

1.05 REFERENCE STANDARDS

- A. NADCA Standards: The HVAC system cleaning contractor shall perform the services specified here in accordance with the current published standards of the National Air Duct Cleaners Association (NADCA).
 - 1. All terms in this specification shall have their meaning defined as stated in NADCA Standards.
 - 2. NADCA Standards must be followed with no modifications or deviations being allowed.
- B. The following current standards and publications of the issues currently in effect form a part of this specification to the extent indicated by any reference thereto:
 - 1. NADCA: "ACR-2021, Assessment, Cleaning & Restoration of HVAC systems".
 - 2. NADCA: "Understanding Microbial Contamination in HVAC Systems".
 - 3. NADCA: "Introduction of HVAC System Cleaning Services".
 - 4. NADCA: "Requirements for Installation of Service Openings in HVAC Systems".
 - 5. NADCA: "Biological Air Quality Considerations for non-healthcare, as built environment".
 - 6. NADCA: "Chemical Product Applications in HVAC Systems".
 - 7. NADCA: "Inspection & Cleaning of open Air Plenum in HVAC Systems".
 - 8. Underwriter's Laboratories (UL): UL Standard 181.
 - 9. ASHRAE Standard 62.1: "Ventilation for Acceptable Indoor Air Quality".
 - 10. Environmental Protection Agency (EPA): "Building Air Quality".
 - 11. SMACNA: "HVAC Duct Construction Standards - Metal and Flexible".
 - 12. North American Insulation Manufacturers Association (NAIMA): "Cleaning Fibrous Glass Insulated Air Duct Systems".
- C. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2024.
- D. NADCA ACR - The NADCA Standard for Assessment, Cleaning, and Restoration of HVAC System; 2021.
- E. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors; Current Edition, Including All Revisions.
- F. UL 181A - Closure Systems for Use with Rigid Air Ducts; Current Edition, Including All Revisions.

1.06 SUBMITTALS

- A. Product Data: Provide product description and list of materials.
- B. Process: Submit complete process for treatment, encapsulation and repair.

1.07 HEALTH AND SAFETY

- A. Safety Standards: Cleaning contractors shall comply with applicable federal, state, and local requirements for protecting the safety of the contractors employees building occupants, and the environment. In particular, all applicable standards of the Occupational Safety and Health Administration (OSHA) shall be followed when working in accordance with this specification.

- B. Occupant Safety: No processes or materials shall be employed in such a manner that they will introduce additional hazards into occupied spaces.
- C. Disposal of Debris: All debris removed from the HVAC System shall be disposed of in accordance with applicable federal, state and local requirements.

PART 2 PRODUCTS

2.01 TOOLS AND EQUIPMENT

- A. Vacuum Devices and Other Tools: Exceptionally clean, in good working order, and sealed when brought into the facility.
- B. Vacuum Devices That Exhaust Air Inside Building, Including Hand-Held and Wet Vacuums: Equipped with HEPA filtration with 99.97 percent collection efficiency for minimum 0.3-micron size particles and DOP test number.
- C. Vacuum Devices That Exhaust Air Outside Building, Including Truck- and Trailer-Mounted Types: Equipped with particulate collection including adequate filtration to contain debris removed from the HVAC system; exhausted in manner that prevents contaminant re-entry to building; compliant with applicable regulations as to outdoor environmental contamination.

2.02 REPLACEMENT PRODUCTS

- A. Fibrous Glass Insulation: Provide material complying with UL 181 equivalent to existing material in quality and thickness.
- B. Repair or replace all damaged insulation in order to provide complete coverage of all duct surfaces. Insulation shall be in accordance with Section 20 07 00.

2.03 SURFACE TREATMENTS

- A. Anti-Microbial Materials: EPA registered specifically for use on non-porous HVAC system surfaces and applied per manufacturer's instructions.
- B. Surface Coating for Fibrous Glass Materials: Water-based, zero VOC; flame spread index less than 25, smoke developed index less than 450, Class A, when tested in accordance with ASTM E84.
- C. Biocidal agents shall be used to control the growth of fungal or bacteriological contaminants and shall be performed after the removal of surface deposits and debris.
- D. Biocidal coating shall be a polyacrylate copolymer emulsion specifically formulated for long-term fungicidal activity, with no loss of activity on aging. It shall be formulated to effectively prevent the spread of molds and odor-causing bacteria on its surface and should provide a tough, elastic, decorative finish that allows for movement without splitting to create lodging places for bacteria.
- E. Biocidal Coating shall be Fosters 40-20 or equal
 1. Color: White
 2. Application Consistency: Brush or Airless Spray.
 3. Average Weight / US gallon (ASTM D1475): 11.9 lbs.
 4. Average Non-Volatile (ASTM D 2396): 58% by volume coverage range, .25 gal./100 sq.ft, 0.020 in wet thickness, 0.011 in dry thickness.
 5. Drying Time (ASTM 1640): Set to Touch: 4 hours, Dry Through: 16 hours.
 6. Water Vapor Permeance (ASTM F 1249): Tested at 90% R.H. differential and 100°F, 6.0 perms at 0.011 in.
 7. Service Temperature Limits (ASTM 70): Temperature at coated surface: -20°F to 200°F
 8. Safety: Wet flammability ASTM D 3278: No flash to boiling at 210°F.
 9. Surface Burning Characteristics (ASTM E 84): Flame Spread: 15; Smoke Developed: 5.

2.04 INSULATION LOADINGS

- A. Insulation encapsulation coating shall be a water based protective coating formulated with a preservative that prevents the growth of mold and mildew on the surface itself. It shall form a durable, flexible film over the insulation.
- B. Insulation encapsulation coating shall be Design polymeric DP2540 or equal
 - 1. Color: Black
 - 2. Base: Water
 - 3. Chemical Family: Synthetic Latex
 - 4. Solids Content: 59% $\pm$ 2%
 - 5. Viscosity: Approx. 4,000 to ,000 cps
 - 6. Application Temperature: 40°F - 110°F.
 - 7. Storage Temperature: 40°F - 110°F
 - 8. Service Temperature: 0°F - 200°F
 - 9. Freeze / Thaw Stability: Protect from freezing
 - 10. Flammability: Non-flammable wet
 - 11. Flash Point: No flash to boiling
 - 12. Shelf Life: 1 Year (unopened containers)
 - 13. Cure Time: 4-16 hours
 - 14. Coverage: 8

PART 3 EXECUTION

3.01 PROJECT CONDITIONS

- A. Comply with applicable federal, state, and local requirements.
- B. Perform cleaning, inspection, and remediation in accordance with the recommendations of NADCA "Assessment, Cleaning and Restoration of HVAC Systems" (ACR) and as specified herein.
- C. Where NADCA ACR uses the terms "recommended", "highly recommended", or "ideally" in regard to a certain procedure or activity, do that unless it is clearly inapplicable to the project.
- D. Take precautions to prevent introduction of additional hazards into occupied spaces.
- E. Comply with requirements of Section 01 57 19.
- F. Obtain Owner's approval of proposed temporary locations for large equipment.
- G. Designate a decontamination area and obtain Owner's approval.
- H. When portions of the facility are to remain occupied or in operation during cleaning activities, provide adequate controls or containment to prevent access to spaces being cleaned by unauthorized persons and provide detailed instructions to Owner as to these controls or containment.
- I. If unforeseen mold or other biological contamination is encountered, notify Architect immediately, identifying areas affected and extent and type of contamination.

3.02 EXAMINATION

- A. Prior to the commencement of any cleaning work, prepare and submit to Architect a project evaluation and plan for this project, including considerations recommended in NADCA ACR.
- B. Coordinate cleaning plan with indoor air quality control plan specified in Section 01 57 19.
- C. Inspect the system as required to determine appropriate methods, tools, equipment, and protection.
- D. Start of cleaning work constitutes acceptance of existing conditions.
- E. When concealed spaces are later made accessible, examine and document interior conditions prior to beginning cleaning.

- F. Document all instances of mold growth, rodent droppings, other biological hazards, and damaged system components.

3.03 PREPARATION

- A. When cleaning work might adversely affect life safety systems, including fire and smoke detection, alarm, and control, coordinate scheduling and testing and inspection procedures with authorities having jurisdiction.
- B. Ensure that electrical components that might be adversely affected by cleaning are de-energized, locked out, and protected prior to beginning work.
- C. Air-Volume Control Devices: Mark the original position of dampers and other air-directional mechanical devices inside the HVAC system prior to starting cleaning.
- D. Access to Concealed Spaces: Use existing service openings and make additional service openings as required to accomplish cleaning and inspection.
 - 1. Do not cut openings in non-HVAC components without obtaining the prior approval of Owner.
 - 2. Make new openings in HVAC components in accordance with NADCA Standard 05; do not compromise the structural integrity of the system.
 - 3. Do not cut service openings into flexible duct; disconnect at ends for cleaning and inspection.
- E. Ceiling Tile: Lay-in ceiling tile may be removed to gain access to HVAC systems during the cleaning process; protect tile from damage and reinstall upon completion; replace damaged tile.

3.04 CLEANING

- A. Use any cleaning method recommended by NADCA ACR unless otherwise specified; do not use methods prohibited by NADCA ACR, or that will damage HVAC components or other work, or that will significantly alter the integrity of the system.
- B. Obtain Owner's approval before using wet cleaning methods; ensure that drainage is adequate before beginning.
- C. Ducts: Mechanically clean all portions of ducts.
- D. Hoses, Cables, and Extension Rods: Clean using suitable sanitary damp wipes at the time they are being removed or withdrawn from their normal position.
- E. Registers, Diffusers, and Grilles: When removing, take care to prevent containment exposure due to accumulated debris.
- F. Coils: Follow NADCA ACR completely including measuring static pressure drop before and after cleaning; do not remove refrigeration coils from system to clean; report coils that are permanently impacted.
- G. Fibrous Glass Material: Use HEPA vacuuming equipment, under constant negative pressure, do not permit to get wet, and do not damage surfaces; replace material damaged by cleaning operations.
- H. Existing Damaged Fibrous Glass Material: Report to Architect all evidence of damage, deterioration, delaminating, friable material, mold or fungus growth, or moisture that cannot be remedied by cleaning or resurfacing with an acceptable insulation repair coating.
 - 1. Material with active fungal growth is considered unremediable.
 - 2. Remove unremediable material and clean underlying surfaces.
 - 3. Where surface damage can be repaired by applying a coating, do so at no extra cost to Owner.
 - 4. Replace unremediable material at no extra cost to Owner.
- I. Collect debris removed during cleaning; ensure that debris is not dispersed outside the HVAC system during the cleaning process.

- J. Store contaminated tools and equipment in polyethylene bags until cleaned in the designated decontamination area.

3.05 REPAIR

- A. Repair openings cut in the ventilation system so that they do not significantly alter the airflow or adversely impact the facility's indoor air quality.
- B. At insulated ducts and components, accomplish repairs in such a manner as to achieve the equivalent thermal value.
- C. Reseal new openings in accordance with NADCA Standard 05.
- D. Reseal rigid fiber glass duct systems using closure techniques that comply with UL 181 or UL 181A.
- E. When new openings are intended to be capable of being re-opened in the future, clearly mark them and report their locations to Owner in project report documents.

3.06 FIELD QUALITY CONTROL

- A. Ensure that the following field quality control activities are completed prior to application of any treatments or coatings and prior to returning HVAC system to normal operation.
- B. Visually inspect all portions of the cleaned components; if not visibly clean as defined in NADCA ACR, re-clean and reinspect.
- C. Coils: Cleaning must restore the coil pressure drop to within 10 percent of the coil's original installed pressure drop; if original pressure drop is not known, coil will be considered clean if free of foreign matter and chemical residue based on visual inspection.
- D. Notify Architect when cleaned components are ready for inspection.
- E. Notify Owner's testing and inspection agency when cleaned components are ready for inspection.
- F. Owner reserves the right to verify cleanliness using NADCA ACR Surface Comparison Testing or NADCA Vacuum Test.
- G. When directed, re-clean components until they pass.
- H. Contractor shall bear the costs of retesting due to inadequate cleaning.
- I. Submit evidence that all portions of the system required to be cleaned have been cleaned satisfactorily.

3.07 ANTI-MICROBIAL TREATMENT

- A. When directed, apply anti-microbial treatment to internal surfaces.
- B. Apply anti-microbial agent after removal of surface deposits and debris.
- C. Apply anti-microbial treatments and coatings in strict accordance with the manufacturer's written recommendations and EPA registration listing.
- D. Spray coatings directly onto interior ductwork surfaces; do not "fog" into air stream.

3.08 ADJUSTING

- A. After satisfactory completion of field quality control activities, restore adjustable devices to original settings, including, but not limited to, dampers, air directional devices, valves, fuses, and circuit breakers.

3.09 WASTE MANAGEMENT

- A. Double-bag waste and debris in 6 mil, 0.006 inch (0.1524 mm) thick polyethylene plastic bags.
- B. Dispose of debris off-site in accordance with applicable federal, state and local requirements.

END OF SECTION

SECTION 23 05 23
GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Provide all the valves as indicated on the drawings and as specified.
- B. This section includes following general duty valves
 - 1. Angle valves.
 - 2. Globe valves.
 - 3. Ball valves.
 - 4. Butterfly valves.
 - 5. Check valves.
 - 6. Gate valves.
 - 7. Plug valves.
 - 8. Calibrated balancing valves
 - 9. Pressure and safety relief valves
 - 10. Chainwheels.
 - 11. Drain valve

1.02 RELATED REQUIREMENTS

- A. Section 07 84 00 - Firestopping.
- B. Section 08 31 00 - Access Doors and Panels.
- C. Section 23 05 48 - Vibration and Seismic Controls for HVAC.
- D. Section 23 05 53 - Identification for HVAC Piping and Equipment.
- E. Section 23 07 16 - HVAC Equipment Insulation.
- F. Section 23 07 19 - HVAC Piping Insulation.
- G. Section 23 21 13 - Hydronic Piping.
- H. Section 23 22 13 - Steam and Condensate Heating Piping.

1.03 ABBREVIATIONS AND ACRONYMS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene copolymer rubber.
- C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
- D. NRS: Nonrising stem.
- E. OS&Y: Outside screw and yoke.
- F. PTFE: Polytetrafluoroethylene.
- G. RS: Rising stem.
- H. TFE: Tetrafluoroethylene.
- I. WOG: Water, oil, and gas.
- J. WSP: Working steam pressure.

1.04 REFERENCE STANDARDS

- A. API STD 594 - Check Valves: Flanged, Lug, Wafer, and Butt-Welding; 2022.
- B. ASME B1.20.1 - Pipe Threads, General Purpose, Inch; 2013 (Reaffirmed 2018).
- C. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250; 2020.

- D. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24 Metric/Inch Standard; 2025.
- E. ASME B16.10 - Face-to-Face and End-to-End Dimensions of Valves; 2022, with Errata (2023).
- F. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2021.
- G. ASME B16.34 - Valves — Flanged, Threaded, and Welding End; 2025.
- H. ASME B31.1 - Power Piping; 2024.
- I. ASME B31.9 - Building Services Piping; 2020.
- J. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators; 2025, with Errata.
- K. ASTM A48/A48M - Standard Specification for Gray Iron Castings; 2022.
- L. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings; 2004 (Reapproved 2023).
- M. ASTM A216/A216M - Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service; 2021.
- N. ASTM A351/A351M - Standard Specification for Castings, Austenitic, for Pressure-Containing Parts; 2024, with Editorial Revision (2025).
- O. ASTM A395/A395M - Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures; 1999 (Reapproved 2022).
- P. ASTM A536 - Standard Specification for Ductile Iron Castings; 2024.
- Q. ASTM A582/A582M - Standard Specification for Free-Machining Stainless Steel Bars; 2022.
- R. ASTM B61 - Standard Specification for Steam or Valve Bronze Castings; 2015 (Reapproved 2021).
- S. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings; 2017.
- T. AWWA C606 - Grooved and Shouldered Joints; 2022.
- U. MSS SP-45 - Drain and Bypass Connections; 2020.
- V. MSS SP-67 - Butterfly Valves; 2022.
- W. MSS SP-68 - High Pressure Butterfly Valves with Offset Design; 2021.
- X. MSS SP-70 - Gray Iron Gate Valves, Flanged and Threaded Ends; 2011.
- Y. MSS SP-71 - Gray Iron Swing Check Valves, Flanged and Threaded Ends; 2018.
- Z. MSS SP-72 - Ball Valves with Flanged or Butt-Welding Ends for General Service; 2010a.
- AA. MSS SP-78 - Gray Iron Plug Valves, Flanged and Threaded Ends; 2011.
- BB. MSS SP-80 - Bronze Gate, Globe, Angle, and Check Valves; 2019.
- CC. MSS SP-85 - Gray Iron Globe and Angle Valves, Flanged and Threaded Ends; 2011.
- DD. MSS SP-108 - Resilient-Seated Cast Iron Eccentric Plug Valves; 2020.
- EE. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends; 2010, with Errata .
- FF. MSS SP-125 - Check Valves: Gray Iron and Ductile Iron, In-Line, Spring-Loaded, Center-Guided; 2018.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data on valves including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.

- C. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.
- D. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts listings.
- E. Maintenance Materials: Furnish Owner with one wrench for every five plug valves, in each size of square plug valve head.
 - 1. See Section 01 60 00 - Product Requirements for additional provisions.

1.06 QUALITY ASSURANCE

- A. Manufacturer:
 - 1. Obtain valves for each valve type from single manufacturer.
 - 2. Company must specialize in manufacturing products specified in this section, with not less than three years of documented experience.
- B. Welding Materials and Procedures: Comply with ASME BPVC-IX.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Minimize exposure of operable surfaces by setting plug and ball valves to open position.
 - 2. Protect valve parts exposed to piped medium against rust and corrosion.
 - 3. Protect valve piping connections such as grooves, weld ends, threads, and flange faces.
 - 4. Adjust globe, gate, and angle valves to the closed position to avoid clattering.
 - 5. Secure check valves in either the closed position or open position.
 - 6. Adjust butterfly valves to closed or partially closed position.
- B. Use the following precautions during storage:
 - 1. Maintain valve end protection and protect flanges and specialties from dirt.
 - a. Provide temporary inlet and outlet caps.
 - b. Maintain caps in place until installation.
 - 2. Store valves in shipping containers and maintain in place until installation.
 - a. Store valves indoors in dry environment.
 - b. Store valves off the ground in watertight enclosures when indoor storage is not an option.
- C. Exercise the following precautions for handling:
 - 1. Handle large valves with sling, modified to avoid damage to exposed parts.
 - 2. Avoid the use of operating handles or stems as rigging or lifting points.

PART 2 PRODUCTS

2.01 MANUFACTURER

- A. Manufacturer: Subject to compliance with requirements, provide products by the manufacturers specified. The first manufacturer listed represents the basis of design as scheduled and drawn in the construction documents.

2.02 APPLICATIONS

- A. See drawings for specific valve locations.
- B. Listed pipe sizes shown using nominal pipe sizes (NPS) and nominal diameter (DN).
- C. Provide the following valves for the applications if not indicated on drawings:
 - 1. Throttling (Hydronic): Butterfly, Ball, Globe, and Angle.
 - 2. Throttling (Steam): Butterfly, Gate, Ball, and Plug.
 - 3. Isolation (Shutoff): Butterfly, Gate, Ball, and Plug.
 - 4. Swing Check (Pump Outlet):
 - a. Size 2 inch (50 mm, DN) and Smaller: Bronze with bronze disc.

- b. Size 2-1/2 inch (65 mm, DN) and Larger: Iron with lever and weight, lever and spring, center-guided metal, or center-guided with resilient seat.
- 5. Dead-End: Butterfly, single-flange (lug) type.
- D. Substitutions of valves with higher CWP classes or WSP ratings for same valve types are permitted when specified CWP ratings or WSP classes are not available.
- E. Required Valve End Connections for Non-Wafer Types:
 - 1. Steel Pipe:
 - a. Size 2 inch (50 mm, DN) and Smaller: Threaded ends.
 - b. Size 2-1/2 inch (65 mm, DN) and Larger: Grooved ends.
 - 2. Copper Tube:
 - a. Size 2 inch (50 mm, DN) and Smaller: Threaded ends, except solder-joint valve-ends.
 - b. Size 2-1/2 inch (65 mm, DN) and Larger: Grooved ends.
- F. Heating Hot Water Valves:
 - 1. Size 2 inch (50 mm, DN) and Smaller, Brass and Bronze Valves:
 - a. Threaded ends.
 - b. Angle: Bronze disc, Class 125.
 - c. Ball: Full port, one piece, brass trim.
 - d. Swing Check: Bronze disc, Class 125.
 - e. Gate: NRS, Class 125.
 - f. Globe: Bronze disc, Class 125.
 - 2. Size 2-1/2 inch (65 mm, DN) and Larger, Iron Valves:
 - a. 2-1/2 inch (65 mm, DN) to 4 inch (100 mm, DN): Threaded ends.
 - b. Ball: 2-1/2 inch (65 mm, DN) to 10 inch (250 mm, DN), Class 150.
 - c. Single-Flange Butterfly: 2-1/2 inch (65 mm, DN) to 12 inch (300 mm, DN), aluminum-bronze disc, EPDM seat, 200 CWP.
 - d. Single-Flange Butterfly: 14 inch (350 mm, DN) to 24 inch (600 mm, DN), aluminum-bronze disc, EPDM seat, 150 CWP.
 - e. Grooved-End Butterfly: 2-1/2 inch (65 mm, DN) to 12 inch (300 mm, DN), 175 CWP.
 - f. Swing Check: Metal seats, Class 125.
 - g. Swing Check: 2-1/2 inch (65 mm, DN) to 12 inch (300 mm, DN), lever and spring closure control, Class 125.
 - h. Grooved-End Swing Check: 3 inch (80 mm, DN) to 12 inch (300 mm, DN), 300 CWP.
 - i. Center-Guided Check: Compact-wafer, metal seat, Class 125.
 - j. Plate-Type Check: Single plate, metal seat, Class 125 .
 - k. Gate: NRS, Class 125.
 - l. Globe: 2-1/2 inch (65 mm, DN) to 12 inch (300 mm, DN), Class 125.

2.03 GENERAL REQUIREMENTS

- A. All isolation valves, control valves and unions shall have threaded end connection if 2" or smaller, flanged connection otherwise.
- B. Shut off valves shall be provided in the following locations
 - 1. At each piece of equipment at eac connection to isolate it for maintenance. Shutoff valves shall be placed upstream of a union to allow full removal of the equipment side piping.
 - 2. At all riser exits/entrances for all piping systems to facilitate floor or zone shut down.
 - 3. At the piping entrance to building from the central utility plant.
 - 4. Immediate on each side of pump a minimum of 3 pipe diameters from inlet.
- C. Provide valve materials suitable for service and temperature of respective systems, especially wiht respect to discs, plugs, balls, linings, gaskets, and lubricants of globes valves, plug cocks, ball valves etc.

- D. Valve Pressure and Temperature Ratings: No less than rating indicated; as required for system pressures and temperatures.
- E. Valve Sizes: Match upstream piping unless otherwise indicated.
- F. Valve Flange: Same pressure rating as valve.
- G. Valve Actuator Types:
 - 1. Gear Actuator: Quarter-turn valves 8 inch (200 mm, DN) and larger.
 - 2. Handwheel: Valves other than quarter-turn types.
 - 3. Hand Lever: Quarter-turn valves 6 inch (150 mm, DN) and smaller.
 - 4. Wrench: Plug valves with square heads.
 - 5. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator, of size and with chain for mounting height, as indicated in the "Valve Installation" Article.
- H. Valves in Insulated Piping: Provide 2 inch (50 mm, DN) stem extensions and the following features:
 - 1. Gate Valves: Rising stem.
 - 2. Ball Valves: Extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
 - 3. Butterfly Valves: Extended neck.
 - 4. Memory Stops: Fully adjustable after insulation is installed.
- I. Memory Stops: Fully adjustable after insulation is installed.
- J. Valve-End Connections:
 - 1. Threaded End Valves: ASME B1.20.1.
 - 2. Flanges on Iron Valves: ASME B16.1 for flanges on iron valves.
 - 3. Pipe Flanges and Flanged Fittings 1/2 inch (15 mm, DN) through 24 inch (600 mm, DN): ASME B16.5.
 - 4. Solder Joint Connections: ASME B16.18.
 - 5. Grooved End Connections: AWWA C606.
- K. General ASME Compliance:
 - 1. Ferrous Valve Dimensions and Design Criteria: ASME B16.10 and ASME B16.34.
 - 2. Power Piping Valves: ASME B31.1.
 - 3. Building Services Piping Valves: ASME B31.9.
- L. Bronze Valves:
 - 1. Fabricate from dezincification resistant material.
 - 2. Copper alloys containing more than 15 percent zinc are not permitted.
- M. Valve Bypass and Drain Connections: MSS SP-45.
- N. Contractor shall provide similar metals end, if not available, provide for proper connections between dissimilar metals.
- O. Wheel handles to be non-heating style cast from malleable iron ASTM A197.
- P. Mark each valve at the factory with the following minimum information, engraved, stamped or cast on each valve or metal tag permanently attached to the valve.
 - 1. Manufacturer's name.
 - 2. Catalog or Figure number.
 - 3. Size and pressure class.
 - 4. Arrows shall indicate direction of flow on check, globe, angle, non-return and eccentric plug valves.
 - 5. UL Approved valves and shall bear the UL label.
- Q. Items not allowed
 - 1. 3-piece ball valves are not acceptable.

2. Gate valves are not acceptable for any applications.
3. Soldered valves and unions are not generally acceptable but are allowed within valve kits serving reheat coils and fan coil units only for valves 2" and less at contractor's discretion.

R. Source Limitations: Obtain each valve type from a single manufacturer.

2.04 BRONZE, ANGLE VALVES

- A. CWP Rating: Class 125: 200 psi (1,380 kPa) and Class 150: 300 psi (2,070 kPa):
1. Comply with MSS SP-80, Type 1.
 2. Body: Bronze; ASTM B62, with integral seat and screw in bonnet.
 3. Ends: Threaded.
 4. Stem: Bronze.
 5. Disc: Bronze, PTFE, or TFE.
 6. Packing: Asbestos free.
 7. Handwheel: Bronze or aluminum.

2.05 BRONZE, GLOBE VALVES

- A. CWP Rating: Class 125: 200 psi (1,380 kPa):
1. Comply with MSS SP-80, Type 1.
 2. Body: Bronze; ASTM B62, with integral seat and screw in bonnet.
 3. Ends: Threaded or solder joint.
 4. Stem and Disc: Bronze or PTFE.
 5. Packing: Asbestos free.
 6. Handwheel: Malleable iron.

2.06 BRONZE, GLOBE VALVES

- A. Manufacturer:
1. Up to 2": Nibco T-256-AP
 2. 2.5" and larger: Nibco F-768-B
- B. 2 inches and Smaller: MSS SP 80, Class 200, bronze body, bronze trim, union bonnet, renewable stainless steel full plug disc, hand wheel, Teflon composition disc, class 200 threaded end connections.
- C. 2.5" and Greater: MSS SP 85, Class 250, Iron body, bronze mounted trim, bolted bonnet, renewable seat and disc, Class 250 flanged end connections.
- D. Ratings for Class 125 and Class 250:
1. Class 125:
 - a. WOG Rating: 200 psi (1,380 kPa).
 - b. WSP Rating: 125 psi (861.8 kPa), saturated.
 2. Class 250: WOG Rating; 300 psi (2,070 kPa).
 3. Comply with MSS SP-80, Type 1.
 4. Body: ASTM B62, bronze with integral seat and screw-in bonnet.
 5. End Connections: Threaded or solder.
 6. Bonnet: NRS; Nonrising Stem.
 7. Nonrising Stem: Bronze.
 8. Disc: PTFE.
 9. Packing: Asbestos free.
 10. Handwheel Operator: Malleable Iron.

2.07 IRON, GLOBE VALVES

- A. CWP Ratings: Class 125: 200 psi (1,380 kPa) and Class 250: 500 psi (3,450 kPa):
1. Comply with MSS SP-85, Type I.
 2. Body: Gray iron; ASTM A126, with bolted bonnet.

3. Ends: Flanged.
4. Trim: Bronze.
5. Packing and Gasket: Asbestos free.
6. Operator: Handwheel or chainwheel.

2.08 CARBON STEEL, GLOBE VALVES

- A. Class 150:
 1. Body: ASTM A216/A216M.
 2. WOG Rating: 150 psi (1,034 kPa).
 3. Bonnet: NRS; Nonrising Stem.
 4. End Connections: Flanged.
 5. Packing and Gasket: Asbestos free.
 6. Operator: Malleable Iron handwheel.
 7. Pressure and Temperature Rating: ASME B16.34.
- B. Class 300:
 1. Body: ASTM A216/A216M.
 2. WOG Rating: 300 psi (2,068 kPa).
 3. Bonnet: NRS; Nonrising Stem.
 4. End Connections: Flanged.
 5. Packing and Gasket: Asbestos free.
 6. Operator: Malleable iron handwheel.
 7. Pressure and Temperature Rating: ASME B16.34.

2.09 BRASS, BALL VALVES

- A. One Piece, Full Port with Brass Trim and Push-to-fit or Threaded Connections:
 1. Comply with MSS SP-110.
 2. CWP Rating: 200 psi (1,379 kPa).
 3. Body: Forged brass.
 4. Ends: Threaded.
 5. Seats: PTFE or TFE.
 6. Stem: Brass.
 7. Ball: Chrome-plated brass.
- B. Two Piece, Full Port with Stainless Steel Trim and Female Thread, Male thread, or Solder Connections:
 1. Comply with MSS SP-110.
 2. SWP Rating: 150 psi (1,035 kPa).
 3. WOG Rating: 600 psi (4,140 kPa).
 4. Vacuum Rating: 28.9 in-Hg (97.9 kPa).
 5. Body: Forged brass.
 6. Seats: PTFE.
 7. Stem: Stainless Steel.
 8. Ball: Chrome-plated brass.
 9. Cap: Include cap-gasket and chain for 3/4 inch (20 mm, DN) hose connection.
- C. Two Piece, Full Port with Press Connection:
 1. WOG Rating: 250 psi (1,724 kPa).
 2. Body: Forged brass.
 3. Seats: EPDM.
 4. Ball: Chrome-plated brass.
 5. Blow-out Proof Stem: Forged brass.
 6. Operator: Provide lockable handle.
 7. Maximum Service Temperature: 250 degrees F (121.1 degrees C).

2.10 BRONZE, BALL VALVES

- A. Manufacturers:
 - 1. Nibco, T-585-70-66
 - 2. Apollo Series, 77-140
 - 3. Or equal.
- B. General: MSS SP 110, 600 psi WOG, bronze body, stainless steel ball, full port, Teflon seats, blow-out proof stainless steel stem, threaded ends, level handle. Provide stem extension for insulated application.
 - 1. Fabricate from dezincification resistant material.
 - 2. Copper alloys containing more than 15 percent zinc are not permitted.
- C. One Piece, Reduced Port with Bronze Trim:
 - 1. Comply with MSS SP-110.
 - 2. CWP Rating: 400 psi (2,758 kPa).
 - 3. Ends: Threaded.
 - 4. Seats: PTFE.
- D. Two Piece, Full Port with Bronze or Brass Trim:
 - 1. Comply with MSS SP-110.
 - 2. WSP Rating: 150 psi (1,035 kPa).
 - 3. WOG Rating: 400 psi (2,758 kPa).
 - 4. Body: Forged bronze or dezincified-brass alloy.
 - 5. End Connections: Pipe thread or solder.
 - 6. Seats: PTFE.
 - 7. Stem: Bronze or brass.
 - 8. Ball: Chrome plated brass.
 - 9. Operator: Provide lockable handle and stem extension.

2.11 IRON, SINGLE FLANGE BUTTERFLY VALVES

- A. Manufacturers:
 - 1. Nibco LD-2000-3
- B. Class 200, ductile iron body, lug ends, 316 stainless steel stem with copper alloy upper and lower stem bushings, extended neck, aluminum bronze disc, resilient replaceable EPDM molded in seat liner, brass collar and level lock operating mechanism.
- C. Wafer Style:
 - 1. Size: As indicated on drawings, Class 200.
 - 2. Comply with MSS SP-67, Type I.
 - 3. Wafer Style, CWP Ratings:
 - a. Sizes 2 to 12 inch (50 to 300 mm, DN): 200 psi (1380 kPa).
 - b. Sizes 14 to 24 inch (350 to 600 mm, DN): 150 psi (1034 kPa).
 - c. Vacuum Service: Down to 29.9 in-Hg (101.2 kPa).
 - 4. Body Material: ASTM A126 cast iron or ASTM A536 ductile iron.
 - 5. Stem: One or two-piece stainless steel.
 - 6. Seat: NBR.
 - 7. Disc: Aluminum-bronze.
 - 8. Removable Manual Actuator: Lockable handle or worm-gear-connected handwheel with open/close position indication.
 - 9. Service Temperature Range: Minus 30 to 250 degrees F (Minus 34.4 to 121.1 degrees C).
- D. Furnish chain-wheel operators for valves 6 inches and larger mounted over 8 feet above finished floor.
 - 1. Operator: Gear operator with handwheel over direct-mount actuator base.

2.12 BRASS, INLINE CHECK VALVES

- A. Class 150: CWP Rating: 200 psi (1,380 kPa) .
- B. Maximum Service Temperature: 250 degrees F (121.1 degrees C).
- C. Body: Forged brass.
- D. Disc: Forged brass.
- E. Seal: PTFE, bubble tight.
- F. End-Connections: Press.

2.13 BRASS, HORIZONTAL SWING CHECK VALVES

- A. Threaded End-Connections:
 - 1. Class 125: CWP Rating: 200 psi (1,380 kPa).
 - 2. Body: Forged brass.
 - 3. Disc: Forged brass.
 - 4. Hinge-Pin, Screw, and Cap: Forged brass.

2.14 CHECK VALVES

- A. Manufacturers:
 - 1. Nibco, Inc
 - 2. Crane Valve, North America
 - 3. Stockham
- B. Horizontal Swing Check Valves:
 - 1. 2 inches and smaller for Hydronic Application: Nibco T-453-B
 - a. MSS SP 80, Class 200, bronze body and cap, bronze regrindable seat, renewable bronze disc, class 200 threaded end connections.
 - 2. 2-1/2 inches and larger for Hydronic Application: Nibco F-968-B
 - a. MSS SP 71 Type 1, Class 250, cast iron body, bolted bonnet, renewable bronze seat and disc, class 250 flanged end connections.
- C. Class 125:
 - 1. Pressure and Temperature Rating: MSS SP-80, Type 3.
 - 2. Design: Y-pattern, horizontal or vertical flow.
 - 3. WSP Rating: 200 psi (1,380 kPa).
 - 4. Body: Bronze, ASTM B62.
 - 5. End Connections: Threaded or soldered.
 - 6. Disc: Bronze.

2.15 IRON, FLANGED END SWING CHECK VALVES

- A. Class 125:
 - 1. 150 psi (1,035 kPa) with metal seats.
 - 2. 200 psi (1,380 kPa) with metal seats and nonmetallic-to-metal seats.
- B. Class 250:
 - 1. 300 psi (2,070 kPa) with metal seats.
 - 2. 500 psi (3,450 kPa) with metal seats.

2.16 CARBON STEEL, SWING CHECK VALVES

- A. Class 150:
 - 1. Design: T-pattern, horizontal or vertical flow.
 - 2. Body and Disc: ASTM A216/A216M.
 - 3. CWP Rating: 150 psi (1,034 kPa).
 - 4. End Connections: Flanged.
 - 5. Pressure and Temperature Rating: ASME B16.34.

2.17 STAINLESS STEEL, SWING CHECK VALVES

- A. Class 150:
 - 1. Body and Disc: ASTM A351/A351M-CF8M.
 - 2. Design: T-pattern, horizontal or vertical flow.
 - 3. CWP Rating: 150 psi (1,034 kPa).
 - 4. Connection Ends: Flanged.
 - 5. Pressure and Temperature Rating: ASME B16.34.

2.18 CARBON STEEL, GATE VALVES

- A. Class 150:
 - 1. Body and Disc: ASTM A216/A216M.
 - 2. CWP Rating: 150 psi (1,034 kPa).
 - 3. Bolted Bonnet: OS&Y; Rising Stem.
 - 4. End Connections: Flanged.
 - 5. Packing and Gasket: Asbestos free.
 - 6. Pressure and Temperature Rating: ASME B16.34.

2.19 LUBRICATED PLUG VALVES

- A. Regular Gland and Cylindrical with Threaded Ends:
 - 1. Comply with MSS SP-78, Type II.
 - 2. Class 150:
 - a. Sizes 2-1/2 to 12 inch (65 to 300 mm, DN) , CWP Rating; 200 psi (1,380 kPa).
 - b. Sizes 14 to 24 inch (350 to 600 mm, DN), CWP Rating; 150 psi (1,035 kPa).
 - 3. Body Material: Cast iron with lubrication sealing system.
 - 4. Pattern: Regular or short.
 - 5. Plug: Cast iron or bronze with sealant groove.

2.20 ECCENTRIC PLUG VALVES

- A. Resilient Seating with Flanged Ends.
 - 1. Comply with MSS SP-108.
 - 2. CWP Rating: 175 psi (1,200 kPa) minimum.
 - 3. Body and Plug: Gray or ductile iron.

2.21 CALIBRATED BALANCING VALVES

- A. Manufacturers:
 - 1. Nibco
 - 2. Tour Anderson
 - 3. Stockham
- B. Up to 2 inches:
 - 1. Manual Valve: DZR brass body and internal components, Disc Seat - PTFE, EPDM O-ring, NPT threaded ends, Nibco T-1810.
- C. Over 2 inches: Ductile iron body conforming to ASTM B16, EPDM elastomeric coated disc, integral internal memory stop, graphite stem sealing, flanged end connections.
- D. All balancing valves shall include a concealed memory with a locking tamperproof setting.
- E. All balancing valves shall be furnished with valve manufacturer's performed rigid polyurethane thermal insulation and extended level stem.
- F. All balancing valve sizes shall be sized for accurate readings across flow range anticipated, not for adjacent pipe size. Reducers shall be provided to allow for change of pipe size.

2.22 PRESSURE AND SAFETY RELIEF VALVES

- A. Manufacturers:
 - 1. Nibco Inc

2. Stockham
3. Crane
- B. Valve: Bronze body, Teflon seat, stainless steel valve spring and trim, automatic direct pressure actuated, capacities ASME certified and labeled.
- C. Type and size as applicable, constructed and rated in accordance with ASME, and so stamped.
- D. Piped to safe location outdoors.
- E. Use "pressure relief valves" for unheated liquids.
- F. Use "safety relief valves" for heated liquids, etc.
- G. Valves suitable and rated for proper temperatures.
- H. Valves shall have set pressure indicated but not more than working pressure of protected equipment.
- I. Valves shall open, under test, at set pressure, with tolerance of plus or minus 2 psi for set pressure up to 70 psig, and plus or minus 3 percent for set pressures in excess of 70 psig.
- J. Valves shall have capacity to relieve maximum possible generated energy while maintaining pressure in protected equipment at no more than 10 percent above vessel working pressure.
- K. Provide multiple valves if required for capacity even though only one valve may be shown in drawings.

2.23 AIR VENTS

- A. Manufacturers: Manual Type
 1. Nibco, Inc
 2. Apollo
 3. Crane Valve, North America
- B. Manufacturers: Automatic Type
 1. Hoffman
 2. Taco
 3. Armstrong
- C. Manual Type: 3 inch tall vertical section of 2 inch diameter pipe to form air chamber starting at 2 inch pipe, use 1 inch diameter pipe for all smaller pipes. Install with a minimum of a 3/4 inch ball valve at top of chamber with hose bibb threaded connection and cap.
- D. Automatic Float Type:
 1. Brass or semi-steel body, copper, polypropylene, or solid non-metallic float, stainless steel valve and valve seat; suitable for system operating temperature and pressure; with isolating valve piped to approved plumbing receptor.

2.24 DRAIN VALVES

- A. Manufacturers:
 1. Nibco, Inc.
 2. Apollo
 3. Crane Valve, North America
- B. Up to 3", use ball valve, MSS SP110, 600 psi WOG, two piece bronze body, chrome plated brass ball, full port, Teflon seats, blow-out proof stem, threaded ends, level handle, hose bibb cap and chain. Provide stem extension for insulated applications.
- C. Greater than 3", use butterfly valve with flanged connections.
- D. Bearings: Oil-impregnated bronze or Stainless Steel.
- E. Stem-Seal Packing: Asbestos free.
- F. Plug, Resilient-Seating Material: Approved for potable water service.

2.25 CHAINWHEELS

- A. Description: Valve actuation assembly with sprocket rim, brackets, and chain.
 - 1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
 - 2. Attachment: For connection to ball, butterfly, and plug valve stems.
- B. coil valve
- C. Manufacturers:
 - 1. Griswold (with control valves to be consistent with those specified by controls specification in Division 25).
 - 2. Or equal.
- D. For reheat coil and fan coil unit copper piping 2" and below, provide pre-fabricated valve assembly for supply and return consisting of the following components.
 - 1. Return Isolation Valve: Forged brass (ASTM B283) automatic flow control valve assembly includes integrated isolation ball valve and stainless steel flow control cartridge. Cartridge can be removed for inspection, or can be replaced without disturbing piping connections. Valve housing includes field repairable dual Teflon and EPDM O-ring seal stem, with nickel, plated ball. Valve includes one fixed end (FNPT or SWT) connection and one union (MNPT) connection. Union end includes union nut and EPDM O-ring. Valve body has two ports with one pressure/temperature test valves, and one combination pressure/temperature test valves and manual air vent (CPTA). Valve is fully assembled. Pressure/Temperature Rating: 400 psi/250°F.
 - 2. Supply Isolation Valve: Ball valve and integrated strainer. Valve housing is forged brass with field repairable dual Teflon and EPDM O-ring seal stem, with nickel plated ball. Strainer is 20 mesh stainless steel and can be removed from housing without disturbing pipe connections for inspection or replacement. Valve includes one fixed (FNPT or SWT) connection and one union (FNPT or SWT) connection. Union end includes union nut and EPDM O-ring. Body has one port with combination pressure/temperature test valves and manual air vent (CPTA). Assembly includes drain valve with 3/4" hose connection with cap. Valve is fully assembled. Pressure/Temperature rating: 400 psi/250°F.
 - 3. Union: Forged brass (ASTM B283) union. Union includes one fixed end (FNPT or SWT) connection and one union (MNPT) connection. Union end includes union nut and EPDM O-ring. Union body has one port with combination Pressure/Temperature Test Valves and manual air vent (CPTA). Pressure/Temperature Rating: 400 psi/250°F.
 - 4. Drain Valve: Rated 275 psi/250°F. Brass housing, nickel plated ball, 3/4" NPSH hose connection.
 - 5. Pressure/Temperature Test Valve: Rated 1000 psi/350°F. Brass housing, norel seal.
 - 6. Combination Pressure/Test Valve & Manual Air Vent (CPTA): Pressure/Temperature Test Valve works in conjunction with valve body feature to function as manual air vent. Requires both components to operate as manual air vent.
 - 7. Return components consist of return isolation ball valve with integrated flow control valve, control valve provided by Division 25, and union with CPTA.
 - 8. Supply side components: Combination Y strainer, drain valve, and ball valve with combination Pressure/Test Valve.
 - 9. Contractor shall coordinate between Division 23 and Division 25 subcontractors to decide whether the controls valves are to be supplied to the valve-kit assembly manufacturer or purchased directly by the latter.
 - 10. Sprocket Rim with Chain Guides: Ductile iron include zinc coating.
 - 11. Chain: Hot-dip galvanized steel. Sized to fit sprocket rim.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Exame piping system for compliance with requirements for installation tolerances and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.
- B. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- C. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- D. Examine threads on valve and mating pipe for form and cleanliness.
- E. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- F. Do not attempt to repair defective valves, replace with new valves.

3.02 VALVE APPLICATIONS

- A. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.
- B. Use the following types of shut-off valves:

Device Type	Required Location	Valve Type		
	1. Supply and return	System	Size	Type
Shut-off Valve	at each piece of equipment.	Hydronic	<= 2"	Ball
	2. At each floor level branch from risers.		> 2"	Butterfly
	3. At the base of vertical risers			

3.03 AIR VENT, DRAIN VALVE, AND CALIBRATED BALANCING VALVE APPLICATION

Device Type	Required Locations	Comments
Automatic air vents	1. At all high points where exposed within a mechanical room or roof and can be properly discharged to a receptor.	Pipe to plumbing receptor
Calibrated balancing valves	1. At each floor level branch from risers on return leg.	
Drain valves	1. At low points leaving each piece of equipment and on the equipment itself to allow for drainage if this cannot be accomplished through the pipe drain. 2. At each floor level branch from risers. 3. At all low points in piping. 4. At least one per isolated section caused by shut-off valve placement.	At bottom of riser. Provide full line size drain valve and coordinate floor sink with plumbing. For all others, use table below.
Manual air vents	1. At high points leaving or entering each piece of equipment. 2. At each floor level branch from risers. 3. At all high points in piping 4. At least one per isolated section caused by shut-off valve placement.	

Drain Valve Sizing Chart							
Line Size	3/4 to 1 1/4	1 1/2	2	3	4	6	8
Drain Size	3/4	1	1 1/4	1 1/2	2	3	4

3.04 VALVE INSTALLATION

- A. Piping installation requirements are specified in other Division 23 sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Provide all equipment with shutoff valves. Provide all valves and check valves, specified under this section unless specifically sized, of same size as the pipes in which they are installed unless otherwise indicated. Provide fixture stops.
- C. For all piping not served by a pre-fabricated coil valve kit, install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- D. All hand-controlled line valves are to be gate, ball or butterfly valves, except where throttling control or frequent operation is required, provide globe, or butterfly, unless otherwise shown or specified. Install all globe valves to close against system pressure.
- E. Position gate valves so that stems are in any suitable angle from horizontal to upright position, not inverted. Install valves only in accessible locations. Provide access doors where valves and fittings are not accessible.
- F. Wherever possible, install valves accessible from floor level or maintenance platform. This means that it shall be within 8' of the floor or within a 24" radius of an elevated access location. An elevated access location is defined as those points accessible using a ladder but no more than 3' above the top rung of the ladder, where acceptable ladder lengths include: 6' A-frame, 8' A-frame and extension ladders up to 20' long. Where necessary, extensions are to be provided in high ceilings or congested areas to meet these requirements or piping shall be routed to facilitate this accessibility. Provide guided chain operators on valves 4" and larger over 78" above floor or maintenance platform in equipment areas. Extend chains to within 6' off floor. Provide operating handles for all valves and cocks without integral operators. Provide adequate clearance for easy operation. Install valves in position to allow full stem movement and full movement of handles.
- G. Provide extended level handle to accommodate insulation.
- H. Provide ball blow-down valves and hose adaptors at strainers, air separators, tanks, pipe traps, equipment drains, etc. of same size as blow-off connection.
- I. When located above ceilings, locate drain valve 6 inches from access panels for fixed ceilings and 6 inches above ceiling for accessible ceilings.
- J. Provide relief valves on pressure tanks, low-pressure side of reducing valves, heat exchangers, and expansion tanks.
- K. Select system relief valve capacity greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment.
- L. Pipe relief valve outlet to nearest floor drain.
- M. Provide discharge pipe to atmosphere from all relief and safety valves, sized with area equal to sum of outlet areas of all valves connected thereto, unless indicated larger. Extend to over approved drain receptacle with air gap.
- N. Provide shut-off valves to isolate expansion devices.
- O. Provide open-ended line valve terminations with plugs or blind flanges.
- P. Provide valves at points shown, or specified, and as required for complete isolation of equipment, risers, branches off mains, automatic valves and tanks arranged so as to give complete and regulation control of piping systems through-out the building. Install valves, with

neat appearance and grouping, so that all parts are easily accessible for maintenance. Not all isolation valves are indicated on drawings.

- Q. Install check valves for proper direction of flow and per manufacturer's directions.

3.05 JOINT CONSTRUCTION

- A. Refer to section 232113 for basic piping joint construction.

3.06 TESTING

- A. Test valve bonnets for tightness. Operate valves from closed-to-open-to-closed position while valve is under test pressure.
- B. Test automatic valves including solenoid valves, expansion valves, water regulating valves, pressure reducing valves, pressure relief valves, safety valves and temperature and pressure relief valves for proper operation at settings indicated.
- C. Insure that valves are field checked for packing and lubricant and that disc is for service intended. Replace leaking packing. Service valves which do not operate smoothly and properly with suitable lubricant before placing in operation.
- D. Test relief valves, safety relief valves, safety valves and temperature and pressure relief valves three times.

3.07 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.08 EXAMINATION

- A. Discard all packing materials and verify that valve interior, including threads and flanges, are completely clean without signs of damage or degradation that could result in leakage.
- B. Verify valve parts to be fully operational in all positions from closed to fully open.
- C. Confirm gasket material to be suitable for the service, to be of correct size, and without defects that could compromise effectiveness.
- D. Should valve is determined to be defective, replace with new valve.

3.09 INSTALLATION

- A. Provide unions or flanges with valves to facilitate equipment removal and maintenance while maintaining system operation and full accessibility for servicing.
- B. Provide separate valve support as required and locate valve with stem at or above center of piping, maintaining unimpeded stem movement.
- C. Where valve support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc-rich primer to welds.
- D. Install check valves where necessary to maintain direction of flow as follows:
 - 1. Lift Check: Install with stem plumb and vertical.
 - 2. Swing Check: Install horizontal maintaining hinge pin level.
 - 3. Orient plate-type and center-guided into horizontal or vertical position, between flanges.
- E. Provide chainwheels on operators for valves 4 NPS (100 DN) and larger where located 96 inches (2.4 m) or more above finished floor, terminating 60 inches (1.5 m) above finished floor.

END OF SECTION

SECTION 23 05 93
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Testing, adjusting and balancing of:
 - 1. Air Systems
 - 2. Hydronic Piping Systems
 - 3. Refrigeration Systems
 - 4. Existing Systems

1.02 GENERAL REFERENCES

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Contract Documents: Refer to complete set of Contract Documents for requirements that are related to or may affect the work described in this Section.

1.03 REFERENCE STANDARDS

- A. AABC (NSTSB) - AABC National Standards for Total System Balance, 7th Edition; 2016.
- B. ASHRAE Std 110 - Methods of Testing Performance of Laboratory Fume Hoods; 2016, with Errata.
- C. ASHRAE Std 111 - Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems; 2024, with Errata (2025).
- D. SMACNA (TAB) - HVAC Systems Testing, Adjusting and Balancing; 2023.

1.04 ABBREVIATIONS AND ACRONYMS

- A. AABC: Associated Air Balance Council.
- B. NEBB: National Environmental Balancing Bureau.
- C. TAB: Testing, adjusting, and balancing.
- D. TABB: Testing, Adjusting and Balancing Bureau

1.05 DEFINITIONS

- A. Independent TAB Specialist: A TAB Specialist that is wholly independent of, and not a subsidiary to, any contractor or sub-contractor with an interest in the Project.
 - 1. Independent TAB Specialist shall be sub-contracted directly to Contractor.
- B. TAB Specialist: An entity engaged to perform TAB Work.

1.06 SUBMITTALS

- A. Action Submittals
 - 1. Sustainable and Renewable Products Submittals:
 - a. Air-Balance Report for Sustainable and Renewable Products Prerequisite IEQ 1: Documentation of work performed for ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
 - b. TAB Report for Sustainable and Renewable Products Prerequisite EA 2: Documentation of work performed for ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."
 - 2. Regulatory Submittals:
 - a. Complete and certify the Illinois Department of Public Health (IDPH) Air Balancing Matrix – 5-G (current version).
 - 3. Strategies and Procedures Plan: Within 90 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.
 - 4. Certified TAB reports.

- a. The product is a 'Major' piece of equipment
 - b. The product contains refrigerant
 - c. The cost of a group of products serving a given function constitutes 5% or greater of the sub-contractor's budget, excluding labor.
5. Embodied Carbon Submittals
 - a. Order of Preferred Submittals: For products which require an embodied carbon submittal (described above), one of the following must be provided. The submittal must be that with the highest preference available. The order preference, from highest to lowest is:
 - 1) Product Specific, Facility Specific EPD
 - 2) Product Specific EPD
 - 3) Industry Average EPD
 - 4) TM65 Manufacturer Form with Mid-Level Calculation data
 - 5) TM65 Manufacturer Form with Basic Calculation data
- B. Informational Submittals
 1. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
 2. Contract Documents Examination Report: Within 45 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.
 3. Instrument calibration reports, to include the following:
 - a. Instrument type and make.
 - b. Serial number.
 - c. Application.
 - d. Dates of use.
 - e. Dates of calibration.
 4. TAB Plan: Submit a written plan indicating the testing, adjusting, and balancing standard to be followed and the specific approach for each system and component.
 - a. Submit to Architect.
 - b. Submit to the Commissioning Authority.
 - c. Submit six weeks prior to starting the testing, adjusting, and balancing work.
 - d. Include certification that the plan developer has reviewed Contract Documents, the equipment and systems, and the control system with the Architect and other installers to sufficiently understand the design intent for each system.
 - e. Include at least the following in the plan:
 - 1) Preface: An explanation of the intended use of the control system.
 - 2) List of all air flow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.
 - 3) Copy of field checkout sheets and logs to be used, listing each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.
 - 4) Identification and types of measurement instruments to be used and their most recent calibration date.
 - 5) Discussion of what notations and markings will be made on the duct and piping drawings during the process.
 - 6) Final test report forms to be used.
 - 7) Detailed step-by-step procedures for TAB work for each system and issue, including:
 - (a) Terminal flow calibration (for each terminal type).
 - (b) Diffuser proportioning.
 - (c) Branch/submain proportioning.

- (d) Total flow calculations.
 - (e) Rechecking.
 - (f) Diversity issues.
 - 8) Expected problems and solutions, etc.
 - 9) Criteria for using air flow straighteners or relocating flow stations and sensors; analogous explanations for the water side.
 - 10) Details of how TOTAL flow will be determined; for example:
 - (a) Air: Sum of terminal flows via control system calibrated readings or via hood readings of all terminals, supply (SA) and return air (RA) pitot traverse, SA or RA flow stations.
 - (b) Water: Pump curves, circuit setter, flow station, ultrasonic, etc.
 - 11) Specific procedures that will ensure that both air and water side are operating at the lowest possible pressures and methods to verify this.
 - 12) Confirmation of understanding of the outside air ventilation criteria under all conditions.
 - 13) Method of verifying and setting minimum outside air flow rate will be verified and set and for what level (total building, zone, etc.).
 - 14) Method of checking building static and exhaust fan and/or relief damper capacity.
 - 15) Proposed selection points for sound measurements and sound measurement methods.
 - 16) Methods for making coil or other system plant capacity measurements, if specified.
 - 17) Time schedule for TAB work to be done in phases (by floor, etc.).
 - 18) Description of TAB work for areas to be built out later, if any.
 - 19) Time schedule for deferred or seasonal TAB work, if specified.
 - 20) False loading of systems to complete TAB work, if specified.
 - 21) Exhaust fan balancing and capacity verifications, including any required room pressure differentials.
 - 22) Interstitial cavity differential pressure measurements and calculations, if specified.
 - 23) Procedures for field technician logs of discrepancies, deficient or uncompleted work by others, contract interpretation requests and lists of completed tests (scope and frequency).
 - 24) Procedures for formal progress reports, including scope and frequency.
 - 25) Procedures for formal deficiency reports, including scope, frequency and distribution.
5. Field Quality-control Testing of Laboratory Fume Hoods:
- a. Product Data sheets for all equipment proposed for use in on-site as-installed testing.
 - b. Sample Test Report.
 - c. List of laboratory fume hoods to be tested. Submit a minimum of one week prior to commencement of testing.
 - d. Test data demonstrating that each type of fume hood provided for the project has been successfully tested in the factory as per requirements of Section 11 53 13.
6. Field Logs: Submit at least twice a week to the Commissioning Authority.
7. Control System Coordination Reports: Communicate in writing to the controls installer all setpoint and parameter changes made or problems and discrepancies identified during TAB that affect, or could affect, the control system setup and operation.
8. Progress Reports.
9. Final Report: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
- a. Submit under provisions of Section 01 40 00.

- b. Submit to the the Commissioning Authority within two weeks after completion of testing, adjusting, and balancing.
 - c. Revise TAB plan to reflect actual procedures and submit as part of final report.
 - d. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Architect and for inclusion in operating and maintenance manuals.
 - e. Provide reports in soft cover, letter size, 3-ring binder manuals, complete with index page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.
 - f. Include actual instrument list, with manufacturer name, serial number, and date of calibration.
 - g. Form of Test Reports: Where the TAB standard being followed recommends a report format use that; otherwise, follow ASHRAE Std 111.
 - h. Units of Measure: Report data in both I-P (inch-pound) and SI (metric) units.
 - i. Include the following on the title page of each report:
 - 1) Name of Testing, Adjusting, and Balancing Agency.
 - 2) Address of Testing, Adjusting, and Balancing Agency.
 - 3) Telephone number of Testing, Adjusting, and Balancing Agency.
 - 4) Project name.
 - 5) Project location.
 - 6) Project Architect.
 - 7) Project Engineer.
 - 8) Project Contractor.
 - 9) Project altitude.
 - 10) Report date.
- C. Record Documents
- 1. Record actual locations of flow measuring stations and balancing valves and rough setting.

1.07 QUALITY ASSURANCE

- A. Engage an Independent TAB Specialist certified by AABC, NEBB, or TABB having minimum of three years documented experience.
 - 1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC or NEBB or TABB and a Professional Engineer licensed in the State in which the Project is located.
 - 2. TAB Technician: Employee of the TAB contractor and who is certified by AABC or NEBB, or TABB as a TAB technician.
- B. TAB Conference: Meet with Construction Manager on approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Require the participation of the TAB field supervisor and technicians. Provide seven days advance notice of scheduled meeting time and location.
 - 1. Agenda Items:
 - a. The Contract Documents examination report.
 - b. The TAB plan.
 - c. Coordination and cooperation of trades and subcontractors.
 - d. Coordination of documentation and communication flow.
- C. Certify TAB field data reports and perform the following:
 - 1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
 - 2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.
- D. TAB Report Forms: Use standard TAB contractor's forms approved by Architect.

- E. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."
- F. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
- G. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."
- H. Code Compliance: Perform tests in the presence of Authority Having Jurisdiction (AHJ) where required by the AHJ.
- I. Owner Witness: Perform tests in the presence of the Commissioning Authority, Architect, or Owner's representative.
- J. Do not perform TAB work until heating, ventilating, and air conditioning equipment has been completely installed and is operating continuously as required.
- K. Conduct air testing and balancing with clean filters in place. Clean strainers prior to performing hydronic testing and balancing.

1.08 PROJECT CONDITIONS

- A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.
- B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.
- C. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.09 COORDINATION

- A. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.
- B. Perform TAB after leakage and pressure tests on distribution systems have been satisfactorily completed.

1.10 WARRANTY

- A. Warranty of materials and workmanship as required by section 20 00 00, General Mechanical Requirements and Division 01, General Requirements
- B. In addition, provide:
 - 1. TAB Agency provides warranty for a period of 90 days following submission of completed report, during which time, Owner may request a recheck of up to 10 percent of total number of terminals, or resetting of outlet, coil, or device listed in the final TAB report.
 - 2. Guarantee: Meet the requirements of the following programs:
 - a. Provide a guarantee on NEBB or ABBC forms stating that the agency will assist in completing the requirements of the Contract Documents if the TAB Agent fails to comply with the Contract Documents. Guarantee includes the following provisions:
 - 1) The certified Agent has tested, adjusted, and balanced systems according to the Contract Documents.
 - 2) Systems are balanced to optimum performance capabilities within design and installation limits.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
- B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.
- C. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.
- D. Examine the approved submittals for HVAC systems and equipment.
- E. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- F. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they meet the leakage class of connected ducts as specified in Division 23 Section "HVAC Ducts and Casings" and are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.
- G. Examine equipment performance data including fan and pump curves.
 - 1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
 - 2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.
- H. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- I. Examine test reports specified in individual system and equipment Sections.
- J. Examine test reports specified in individual system and equipment Sections.
- K. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
- L. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.
- M. Examine strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.
- N. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.
- O. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- P. Examine system pumps to ensure absence of entrained air in the suction piping.
- Q. Examine operating safety interlocks and controls on HVAC equipment.
- R. Verify that systems are complete and operable before commencing work. Ensure the following conditions:
 - 1. Systems are started and operating in a safe and normal condition.
 - 2. Temperature control systems are installed complete and operable.
 - 3. Proper thermal overload protection is in place for electrical equipment.
 - 4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
 - 5. Duct systems are clean of debris.

6. Fans are rotating correctly.
 7. Fire and volume dampers are in place and open.
 8. Air coil fins are cleaned and combed.
 9. Access doors are closed and duct end caps are in place.
 10. Air outlets are installed and connected.
 11. Duct system leakage is minimized.
 12. Hydronic systems are flushed, filled, and vented.
 13. Pumps are rotating correctly.
 14. Proper strainer baskets are clean and in place.
 15. Service and balance valves are open.
- S. Submit field reports. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.
- T. Beginning of work means acceptance of existing conditions.

3.02 PREPARATION

- A. Hold a pre-balancing meeting at least one week prior to starting TAB work.
1. Require attendance by all installers whose work will be tested, adjusted, or balanced.
- B. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Architect to facilitate spot checks during testing.
- C. Prepare a TAB plan that includes strategies and step-by-step procedures.
- D. Complete system-readiness checks and prepare reports. Verify the following:
1. Permanent electrical-power wiring is complete.
 2. Hydronic systems are filled, clean, and free of air.
 3. Automatic temperature-control systems are operational.
 4. Equipment and duct access doors are securely closed.
 5. Balance, smoke, and fire dampers are open.
 6. Isolating and balancing valves are open and control valves are operational.
 7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
 8. Windows and doors can be closed so indicated conditions for system operations can be met.
- E. Provide additional balancing devices as required.

3.03 ADJUSTING

- A. Check and record alignment by use of dial indicator of all pumps or similar equipment directly connected to motors by means of flexible couplings. Record and report deficiencies.
1. After one month of successful, continuous operation, equipment to be notched or marked for proper alignment so future repairs will not require re-alignment by means of dial indicator.
- B. Check and record alignment of belt driven equipment to assure grooves of driver pulley are truly aligned with those of the driven sheave and the belts are properly tensioned, free from flutter. In multi-belt drives, confirm that all belts are in the same plane.
- C. Air Handling Systems: Adjust to within plus or minus 5 percent of design for supply systems and plus or minus 10 percent of design for return and exhaust systems.
- D. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.
- E. Hydronic Systems: Adjust to within plus or minus 10 percent of design.
- F. Field Logs: Maintain written logs including:

1. Running log of events and issues.
 2. Discrepancies, deficient or uncompleted work by others.
 3. Contract interpretation requests.
 4. Lists of completed tests.
- G. Ensure recorded data represents actual measured or observed conditions.
- H. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
- I. Mark on drawings the locations where traverse and other critical measurements were taken and cross reference the location in the final report.
- J. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.
- K. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.
- L. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by the Owner.
- M. Check and adjust systems approximately six months after final acceptance and submit report.

3.04 GENERAL REQUIREMENTS

- A. Perform total system balance per the requirements of this section, and in accordance with one of the following:
1. AABC (NSTSB), AABC National Standards for Total System Balance.
 2. NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems"
 3. ASHRAE Std 111, Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning, and Refrigeration Systems.
 4. Comply with requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
 5. SMACNA (TAB).
 6. Maintain at least one copy of the standard to be used at project site at all times.
- B. Begin work after completion of systems to be tested, adjusted, or balanced and complete work prior to Substantial Completion of the project.
- C. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
1. After testing and balancing, patch probe holes in ducts. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Division 20 Section "Mechanical Insulation."
- D. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- E. Take and report testing and balancing measurements in inch-pound (IP) units.
- F. Where HVAC systems and/or components interface with life safety systems, including fire and smoke detection, alarm, and control, coordinate scheduling and testing and inspection procedures with the authorities having jurisdiction.

3.05 PROCEDURES FOR FUME HOOD

- A. General: Test fume hoods as installed to assess airflow velocity, airflow visualization, and level of containment. Perform tests with static mode (set sash position) conditions. Conduct testing as outlined below for 100% of the hoods provided in the Project.
- B. Testing to be performed by firm certified by National Environmental Balancing Bureau - NEBB (FHT).

- C. Preparation: Visit the project site to confirm that construction activities related to the fume hood system(s) and equipment are complete. Review design documents and Contractor's submittals. Verify that mechanical ventilation systems serving the space are functioning and operating in the normal mode. Notify Owner in writing, if conditions exist which preclude proper fume hood testing. Starting of testing constitutes acceptance of site conditions.
- D. Testing Requirements:
1. Perform the following tests, in order:
 - a. Airflow Velocity Test.
 - b. Airflow Visualization Test.
 - c. Tracer Gas Containment Test.
 2. If more than one test procedure is selected, proceed to the next test only if any unsafe condition discovered during current test has been successfully rectified.
 3. Airflow Velocity Test: Comply with Section 9 of NEBB (FHT) Fume Hood Testing Standard - current edition.
 4. Airflow Visualization Test: Comply with Section 10 of NEBB (FHT) Fume Hood Testing Standard - current edition.
 5. Tracer Gas Containment Test:
 - a. Comply with Section 11 of NEBB Fume Hood Testing Standard - current edition.
 - b. Conduct a static mode test of the hood and laboratory configuration. Conduct testing in accordance with ASHRAE Std 110, except as modified herein:
 - 1) Test hood with simulated scientific apparatus set-up within the hood. Apparatus to consist of: two (2) each 1 gal. (3.78 L) round paint cans, one (1) 1' by 1' by 1' (305 mm by 305 mm by 305 mm) cardboard box, and three (3) each 6" by 6" by 12" high (152 mm by 152 mm by 305 mm high) cardboard boxes. Position these items from 6 to 10 inches (152 to 254 mm) behind the sash, randomly distributed, and supported off of the work surface by 2 inch by 2 inch by 2 inch (51 mm by 51 mm by 51 mm) block of any material.
 - 2) 6 liters per minute release rate for tracer gas.
 - 3) Conduct only at the center position for the manikin.
 - 4) Each tracer gas test duration to be 5 minutes.
 - 5) Acceptable test results will be 0.05 PPM or better.
 - 6) At the conclusion of each 5-minute test there will be three rapid walk-by at 1' (305 mm) behind the manikin. Each walk-by to be spaced 30 seconds apart. If a rise in test gas concentration occurs, it cannot exceed 0.10 ppm and must return to 0.05 ppm within 15 seconds.
 - 7) There must be a minimum of three and a maximum of five people in the space in which the fume hood is located during the test procedure.
 - 8) Representatives of the Architect, Engineer, Owner, and Contractor must witness the tests.
 - 9) Test of Alarm: Shut off the fume hood exhaust and verify that the individual fume hood alarm activates.
 - 10) Test individual controls: Test any controls that are provided at the fume hood such as unoccupied cycle override, alarm override, etc.
 - c. Conduct a dynamic mode test of the hood to measure performance parameters of fume hood control systems during the following test events:
 - 1) Sash movement: 25 percent to 100 percent, and 50 percent to 100 percent operating positions.
 - 2) Rapid walk-by in front of the hood. Conduct only at center position for the manikin.
 - 3) Opening and closing main space entrance door, to simulate a person entering or exiting the space.

6. Reporting Requirements: Comply with Section 5 of NEBB (FHT) Fume Hood Testing Standard - current edition. Organize and include, at a minimum, the following information:
 - a. Report Title.
 - b. Report Certification.
 - c. Table of Contents.
 - d. Report Summary/ Remarks.
 - e. Appropriate Forms.
 - f. Instrument Calibration.
 - g. List of Abbreviations Used.
 - h. A room layout drawing for each tested item. Identify: walls; doors; fume hood(s); other present environmental enclosures (e.g. biological safety cabinet(s), laminar flow hood(s), canopy hood(s), etc.); location and airflow pattern of all air supply, return, and exhaust grilles, registers and diffusers.

3.06 AIR SYSTEM PROCEDURE

- A. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities at site altitude.
- B. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.
- C. Measure air quantities at air inlets and outlets.
- D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.
- E. Use volume control devices to regulate air quantities only to extend that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.
- F. Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.
- G. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.
- H. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.
- I. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.
- J. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.
- K. Where modulating dampers are provided, take measurements and balance at extreme conditions. Balance variable volume systems at maximum air flow rate, full cooling, and at minimum air flow rate, full heating.
- L. Measure building static pressure and adjust supply, return, and exhaust air systems to provide required relationship between each to maintain approximately 0.05 inches (12.5 Pa) positive static pressure near the building entries.
- M. Check multi-zone units for motorized damper leakage. Adjust air quantities with mixing dampers set first for cooling, then heating, then modulating.
- N. For variable air volume system powered units set volume controller to air flow setting indicated. Confirm connections properly made and confirm proper operation for automatic variable air volume temperature control.
- O. On fan powered VAV boxes, adjust air flow switches for proper operation.

3.07 WATER SYSTEM PROCEDURE

- A. Adjust water systems to provide required or design quantities.
- B. Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gauges to determine flow rates for system balance. Where flow metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system.
- C. Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.
- D. Effect system balance with automatic control valves fully open to heat transfer elements.
- E. Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.
- F. Where available pump capacity is less than total flow requirements or individual system parts, full flow in one part may be simulated by temporary restriction of flow to other parts.

3.08 COMMISSIONING

- A. See Sections 01 91 13 - General Commissioning Requirements and 23 08 00 for additional requirements.
- B. Perform prerequisites prior to starting commissioning activities.
- C. Fill out Prefunctional Checklists for:
 - 1. Air side systems.
 - 2. Water side systems.
- D. Furnish to the Commissioning Authority, upon request, any data gathered but not shown in the final TAB report.
- E. Re-check minimum outdoor air intake flows and maximum and intermediate total airflow rates for ____ percent of the air handlers plus a random sample equivalent to ____ percent of the final TAB report data as directed by Commissioning Authority.
 - 1. Original TAB agency shall execute the re-checks, witnessed by the Commissioning Authority.
 - 2. Use the same test instruments as used in the original TAB work.
 - 3. Failure of more than 10 percent of the re-checked items of a given system shall result in the rejection of the system TAB report; rebalance the system, provide a new system TAB report, and repeat random re-checks.
 - 4. For purposes of re-check, failure is defined as follows:
 - a. Air Flow of Supply and Return: Deviation of more than 10 percent of instrument reading.
 - b. Minimum Outside Air Flow: Deviation of more than 20 percent of instrument reading; for inlet vane or VFD OSA compensation system using linear proportional control, deviation of more than 30 percent at intermediate supply flow.
 - c. Temperatures: Deviation of more than one degree F (0.5 degree C).
 - d. Air and Water Pressures: Deviation of more than 10 percent of full scale of test instrument reading.
 - e. Sound Pressures: Deviation of more than 3 decibels, with consideration for variations in background noise.
 - 5. For purposes of re-check, a whole system is defined as one in which inaccuracies will have little or no impact on connected systems; for example, the air distribution system served by one air handler or the hydronic chilled water supply system served by a chiller or the condenser water system.
- F. In the presence of the Commissioning Authority, verify that:
 - 1. Final settings of all valves, splitters, dampers and other adjustment devices have been permanently marked.

2. The air system is being controlled to the lowest possible static pressure while still meeting design loads, less diversity; this shall include a review of TAB methods, established control setpoints, and physical verification of at least one leg from fan to diffuser having all balancing dampers wide open and that during full cooling of all terminal units taking off downstream of the static pressure sensor, the terminal unit on the critical leg has its damper 90 percent or more open.
 3. The water system is being controlled to the lowest possible pressure while still meeting design loads, less diversity; this shall include a review of TAB methods, established control setpoints, and physical verification of at least one leg from the pump to the coil having all balancing valves wide open and that during full cooling the cooling coil valve of that leg is 90 percent or more open.
- G. No seasonal tests are required.
- H. No further monitoring is required.
- I. No deferred testing is required.

3.09 ALIGNMENT OF ROTATING EQUIPMENT

- A. Check and record alignment by use of dial indicator of all pumps or similar equipment directly connected to motors by means of flexible couplings. Record and report deficiencies.
1. After one month of successful, continuous operation, equipment to be notched or marked for proper alignment so future repairs will not require re-alignment by means of dial indicator.
- B. Check and record alignment of belt driven equipment to assure grooves of driver pulley are truly aligned with those of the driven sheave and the belts are properly tensioned, free from flutter. In multi-belt drives, confirm that all belts are in the same plane.

3.10 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' "as-built" duct layouts.
- C. For variable-air-volume systems, develop a plan to simulate diversity.
- D. For systems with fans in parallel, develop a plan that includes testing fans operating both individually and in parallel.
- E. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- F. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.
- G. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- H. Verify that motor starters are equipped with properly sized thermal protection.
- I. Check dampers for proper position to achieve desired airflow path.
- J. Check for airflow blockages.
- K. Check condensate drains for proper connections and functioning.
- L. Check for proper sealing of air-handling-unit components.
- M. Verify that air duct system is sealed as specified in Division 23 Section "Metal Ducts."

3.11 TAB PROCEDURES FOR AIR SYSTEMS

- A. Follow standard Air systems procedures of agency certifying TAB Specialist.

3.12 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
 - 1. Measure total airflow.
 - a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.
 - 2. Measure fan static pressures as follows to determine actual static pressure:
 - a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
 - b. Measure static pressure directly at the fan outlet or through the flexible connection.
 - c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
 - d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
 - 3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
 - a. Report the cleanliness status of filters and the time static pressures are measured.
 - 4. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
 - 5. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
 - 6. Obtain approval from Architect for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in Division 23 Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
 - 7. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
 - 1. Measure airflow of submain and branch ducts.
 - a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
 - 2. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.
 - 3. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.
- C. Measure air outlets and inlets without making adjustments.
 - 1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.
- D. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.
 - 1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
 - 2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.13 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

- A. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a minimum set-point airflow with the remainder at maximum-airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.
- B. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
 - 1. Set outdoor-air dampers at minimum, and set return- and exhaust-air dampers at a position that simulates full-cooling load.
 - 2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
 - 3. Measure total system airflow. Adjust to within indicated airflow.
 - 4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.
 - 5. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.
 - a. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.
 - 6. Remeasure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
 - a. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.
 - 7. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit. Record resultant static pressure setpoint value and include in TAB report.
 - 8. Record final fan-performance data.

3.14 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

- A. Prepare test reports with pertinent design data, and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against the approved pump flow rate. Correct variations that exceed plus or minus 5 percent.
- B. Prepare schematic diagrams of systems' "as-built" piping layouts.
- C. For variable-pumping systems, develop a plan to simulate diversity.
- D. For systems with pumps in parallel, develop a plan that includes testing pumps operating both individually and in parallel.
- E. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:
 - 1. Open all manual valves for maximum flow.
 - 2. Check liquid level in expansion tank.
 - 3. Check makeup water-station pressure gage for adequate pressure for highest vent.
 - 4. Check flow-control valves for specified sequence of operation, and set at indicated flow.
 - 5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
 - 6. Set system controls so automatic valves are wide open to heat exchangers.

7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

3.15 TAB PROCEDURES FOR HYDRONIC SYSTEMS

- A. Follow standard Hydronic System procedures of agency certifying TAB Specialist.

3.16 PROCEDURES FOR CONSTANT-FLOW HYDRONIC SYSTEMS

- A. Measure water flow at pumps. Use the following procedures except for positive-displacement pumps:
 1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
 - a. If impeller sizes must be adjusted to achieve pump performance, obtain approval from Architect and comply with requirements in Division 23 Section "Hydronic Pumps."
 2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.
 - a. Monitor motor performance during procedures and do not operate motors in overload conditions.
 3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
 4. Report flow rates that are not within plus or minus 10 percent of design.
- B. Measure flow at all automatic flow control valves to verify that valves are functioning as designed.
- C. Measure flow at all pressure-independent characterized control valves, with valves in fully open position, to verify that valves are functioning as designed.
- D. Set calibrated balancing valves, if installed, at calculated presetsings.
- E. Measure flow at all stations and adjust, where necessary, to obtain first balance.
 1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.
- F. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.
- G. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:
 1. Determine the balancing station with the highest percentage over indicated flow.
 2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
 3. Record settings and mark balancing devices.
- H. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.
- I. Measure the differential-pressure-control-valve settings existing at the conclusion of balancing.
- J. Check settings and operation of each safety valve. Record settings.

3.17 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

- A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

3.18 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS WITH PRESSURE INDEPENDENT CONTROL VALVES

- A. Balance systems with pressure independent control valves by setting systems at maximum flow through individual coils of multiple-coil assemblies.

3.19 PROCEDURES FOR PRIMARY-SECONDARY HYDRONIC SYSTEMS

- A. Balance the primary circuit flow first and then balance the secondary circuits.

3.20 PROCEDURES FOR STEAM SYSTEMS

- A. Measure and record upstream and downstream pressure of each piece of equipment.
- B. Measure and record upstream and downstream steam pressure of pressure-reducing valves.
- C. Check settings and operation of automatic temperature-control valves, self-contained control valves, and pressure-reducing valves. Record final settings.
- D. Check settings and operation of each safety valve. Record settings.
- E. Verify the operation of each steam trap.

3.21 PROCEDURES FOR HEAT EXCHANGERS

- A. Measure water flow through all circuits.
- B. Adjust water flow to within specified tolerances.
- C. Measure inlet and outlet water temperatures.
- D. Measure inlet steam pressure.
- E. Check settings and operation of safety and relief valves. Record settings.

3.22 PROCEDURES FOR MOTORS

- A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
 - 1. Manufacturer's name, model number, and serial number.
 - 2. Motor horsepower rating.
 - 3. Motor rpm.
 - 4. Efficiency rating.
 - 5. Nameplate and measured voltage, each phase.
 - 6. Nameplate and measured amperage, each phase.
 - 7. Starter thermal-protection-element rating.
- B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.23 PROCEDURES FOR CHILLERS

- A. Balance water flow through each evaporator and condenser to within specified tolerances of indicated flow with all pumps operating. With only one chiller operating in a multiple chiller installation, do not exceed the flow for the maximum tube velocity recommended by the chiller manufacturer. Measure and record the following data with each chiller operating at design conditions:
 - 1. Evaporator-water entering and leaving temperatures, pressure drop, and water flow.
 - 2. For water-cooled chillers, condenser-water entering and leaving temperatures, pressure drop, and water flow.
 - 3. Evaporator and condenser refrigerant temperatures and pressures, using instruments furnished by chiller manufacturer.

4. Power factor if factory-installed instrumentation is furnished for measuring kilowatts.
5. Kilowatt input if factory-installed instrumentation is furnished for measuring kilowatts.
6. Capacity: Calculate in tons of cooling.
7. For air-cooled chillers, verify condenser-fan rotation and record fan and motor data including number of fans and entering- and leaving-air temperatures.

3.24 PROCEDURES FOR COOLING TOWERS

- A. Shut off makeup water for the duration of the test, and verify that makeup and blowdown systems are fully operational after tests and before leaving the equipment. Perform the following tests and record the results:
 1. Measure condenser-water flow to each cell of the cooling tower.
 2. Measure entering- and leaving-water temperatures.
 3. Measure wet- and dry-bulb temperatures of entering air.
 4. Measure wet- and dry-bulb temperatures of leaving air.
 5. Measure condenser-water flow rate recirculating through the cooling tower.
 6. Measure cooling-tower spray pump discharge pressure.
 7. Adjust water level and feed rate of makeup water system.
 8. Measure flow through bypass.

3.25 PROCEDURES FO CONDENSING UNITS

- A. Verify proper rotation of fans.
- B. Measure entering- and leaving-air temperatures.
- C. Record compressor data.

3.26 PROCEDURES FOR BOILERS

- A. Hydronic Boilers: Measure and record entering- and leaving-water temperatures and water flow.
- B. Steam Boilers: Measure and record entering-water temperature and flow and leaving-steam pressure, temperature, and flow.

3.27 PROCEDURES FOR HEAT-TRANSFER COILS

- A. Measure, adjust, and record the following data for each water coil:
 1. Entering- and leaving-water temperature.
 2. Water flow rate.
 3. Water pressure drop.
 4. Dry-bulb temperature of entering and leaving air.
 5. Wet-bulb temperature of entering and leaving air for cooling coils.
 6. Airflow.
 7. Air pressure drop.
- B. Measure, adjust, and record the following data for each electric heating coil:
 1. Nameplate data.
 2. Airflow.
 3. Entering- and leaving-air temperature at full load.
 4. Voltage and amperage input of each phase at full load and at each incremental stage.
 5. Calculated kilowatt at full load.
 6. Fuse or circuit-breaker rating for overload protection.
- C. Measure, adjust, and record the following data for each steam coil:
 1. Dry-bulb temperature of entering and leaving air.
 2. Airflow.
 3. Air pressure drop.
 4. Inlet steam pressure.

- D. Measure, adjust, and record the following data for each refrigerant coil:
 - 1. Dry-bulb temperature of entering and leaving air.
 - 2. Wet-bulb temperature of entering and leaving air.
 - 3. Airflow.
 - 4. Air pressure drop.
 - 5. Refrigerant suction pressure and temperature.

3.28 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

- A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.
 - 1. Measure and record the operating speed, airflow, and static pressure of each fan.
 - 2. Measure motor voltage and amperage. Compare the values to motor nameplate information.
 - 3. Check the refrigerant charge.
 - 4. Check the condition of filters.
 - 5. Check the condition of coils.
 - 6. Check the operation of the drain pan and condensate-drain trap.
 - 7. Check bearings and other lubricated parts for proper lubrication.
 - 8. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.
- B. Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished. Verify the following:
 - 1. New filters are installed.
 - 2. Coils are clean and fins combed.
 - 3. Drain pans are clean.
 - 4. Fans are clean.
 - 5. Bearings and other parts are properly lubricated.
 - 6. Deficiencies noted in the preconstruction report are corrected.
- C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.
 - 1. Compare the indicated airflow of the renovated work to the measured fan airflows, and determine the new fan speed and the face velocity of filters and coils.
 - 2. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.
 - 3. If calculations increase or decrease the air flow rates and water flow rates by more than 5 percent, make equipment adjustments to achieve the calculated rates. If increase or decrease is 5 percent or less, equipment adjustments are not required.
 - 4. Balance each air outlet.

3.29 TOLERANCES

- A. Set HVAC system's air flow rates and water flow rates within the following tolerances:
 - 1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
 - 2. Air Outlets and Inlets: Plus or minus 10 percent.
 - 3. Heating-Water Flow Rate: Plus or minus 10 percent.
 - 4. Cooling-Water Flow Rate: Plus or minus 10 percent.
- B. Set HAC systems air flow rates and water flow rates within the following tolerances:
 - 1. Duct mains in supply and return/exhaust systems: $\pm 5\%$ design.
 - 2. Branch ducts and terminal devices: $\pm 7.5\%$ design.
 - 3. Spaces indicated on drawings to have differential pressure maintained shall comply with the following:
 - a. Positively pressurized spaces:

- 1) 0 to +10%.
- 2) 0 to -10%.
- 3) 0 to -10%.
- 4) Supply air CFM to exceed total of return/exhaust CFM by 50 CFM or 10% of supply CFM, whichever is greater.
- b. Negatively pressurized spaces:
 - 1) 0 to -10%.
 - 2) 0 to +10%.
 - 3) 0 to +10%.
 - 4) Total of return/exhaust CFM to exceed supply CFM by 50 CFM or 10% of supply CFM, whichever is greater.
- c. Pressurization (unless noted otherwise on drawings):
 - 1) Minimum: 0.01" water gage.
 - 2) Maximum 0.15" water gage.
4. Hydronic systems: $\pm 5\%$ design.

3.30 REPORTING

- A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.
- B. Status Reports: Prepare weekly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.
- C. FINAL REPORT
- D. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
 1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
 2. Include a list of instruments used for procedures, along with proof of calibration.
- E. Scope
 1. Test, adjust, and balance the following:
 - a. Fire Pumps.
 - b. Sprinkler Air Compressor.
 - c. Electric Water Coolers.
 - d. Steam Condensate Pumps.
 - e. Boiler Feedwater Pumps.
 - f. HVAC Pumps.
 - g. Water Tube Boilers.
 - h. Packaged Steel Water Tube Boilers.
 - i. Packaged Steel Fire Tube Boilers.
 - j. Forced Air Furnaces.
 - k. Direct Fired Furnaces.
 - l. Reciprocating Water Chillers.
 - m. Air Cooled Water Chillers.
 - n. Centrifugal Water Chillers.
 - o. Absorption Water Chillers.
 - p. Induced Draft Cooling Tower.

- q. Blow Through Cooling Tower.
- r. Air Cooled Refrigerant Condensers.
- s. Packaged Roof Top Heating/Cooling Units.
- t. Packaged Terminal Air Conditioning Units.
- u. Unit Air Conditioners.
- v. Computer Room Air Conditioning Units.
- w. Hydronic Pumps
- x. Hydronic Balancing Valves
- y. Hydronic Coils
- z. Steam Coils
- aa. Electric Coils
- bb. Chiller
- cc. Cooling Tower
- dd. Hot Water Boiler
- ee. Shell and Tube heat Exchanger
- ff. Plate and Frame Heat Exchanger
- gg. Energy Recovery Wheels
- hh. Air Coils.
- ii. Evaporative Humidifier.
- jj. Fans
- kk. Variable Volume Air Terminal Units
- ll. Constant Volume Air Terminal Units
- mm. Fan Powered Terminal Units
- nn. Duct Traverses
- oo. Sprayed Coil Dehumidifier.
- pp. Terminal Heat Transfer Units.
- qq. Induction Units.
- rr. Air Handling Units.
- ss. Fans.
- tt. Air Filters.
- uu. Air Inlets and Outlets.
- vv. Controls Compressor.

F. Minimum Data to be Reported

1. General Report Data: In addition to form titles and entries, include the following data:
 - a. Title page.
 - b. Name and address of the TAB contractor.
 - c. Project name.
 - d. Project location.
 - e. Architect's name and address.
 - f. Engineer's name and address.
 - g. Contractor's name and address.
 - h. Report date.
 - i. Signature of TAB supervisor who certifies the report.
 - j. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
 - k. Summary of contents including the following:
 - 1) Indicated versus final performance.
 - 2) Notable characteristics of systems.
 - 3) Description of system operation sequence if it varies from the Contract Documents.
 - l. Nomenclature sheets for each item of equipment.

- m. Data for terminal units, including manufacturer's name, type, size, and fittings.
- n. Notes to explain why certain final data in the body of reports vary from indicated values.
- o. Test conditions for fans and pump performance forms including the following:
 - 1) Settings for outdoor-, return-, and exhaust-air dampers.
 - 2) Conditions of filters.
 - 3) Cooling coil, wet- and dry-bulb conditions.
 - 4) Face and bypass damper settings at coils.
 - 5) Fan drive settings including settings and percentage of maximum pitch diameter.
 - 6) Inlet vane settings for variable-air-volume systems.
 - 7) Settings for supply-air, static-pressure controller.
 - 8) Other system operating conditions that affect performance.
- 2. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
 - a. Quantities of outdoor, supply, return, and exhaust airflows.
 - b. Water and steam flow rates.
 - c. Duct, outlet, and inlet sizes.
 - d. Pipe and valve sizes and locations.
 - e. Terminal units.
 - f. Balancing stations.
 - g. Position of balancing devices.
- 3. Reports: Include all data specified by the TAB Specialist certifying agency.
 - a. NEBB certified TAB Specialists: Include all "shall, should and may" data.
- 4. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:
 - a. Unit Data:
 - 1) Unit identification.
 - 2) Location.
 - 3) Make and type.
 - 4) Model number and unit size.
 - 5) Manufacturer's serial number.
 - 6) Unit arrangement and class.
 - 7) Discharge arrangement.
 - 8) Sheave make, size in inches , and bore.
 - 9) Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).
 - 10) Number, make, and size of belts.
 - 11) Number, type, and size of filters.
 - b. Motor Data:
 - 1) Motor make, and frame type and size.
 - 2) Horsepower and rpm.
 - 3) Volts, phase, and hertz.
 - 4) Full-load amperage and service factor.
 - 5) Sheave make, size in inches, and bore.
 - 6) Center-to-center dimensions of sheave, and amount of adjustments in inches.
 - c. Test Data (Indicated and Actual Values):
 - 1) Total air flow rate in cfm.
 - 2) Total system static pressure in inches wg.
 - 3) Fan rpm.
 - 4) Discharge static pressure in inches wg.
 - 5) Filter static-pressure differential in inches wg.
 - 6) Preheat-coil static-pressure differential in inches wg.

- 7) Cooling-coil static-pressure differential in inches wg.
 - 8) Heating-coil static-pressure differential in inches wg.
 - 9) Outdoor airflow in cfm.
 - 10) Return airflow in cfm.
 - 11) Outdoor-air damper position.
 - 12) Return-air damper position.
 - 13) Vortex damper position.
5. Apparatus-Coil Test Reports:
- a. Coil Data:
 - 1) System identification.
 - 2) Location.
 - 3) Coil type.
 - 4) Number of rows.
 - 5) Fin spacing in fins per inch o.c.
 - 6) Make and model number.
 - 7) Face area in sq. ft.
 - 8) Tube size in NPS.
 - 9) Tube and fin materials.
 - 10) Circuiting arrangement.
 - b. Test Data (Indicated and Actual Values):
 - 1) Air flow rate in cfm.
 - 2) Average face velocity in fpm.
 - 3) Air pressure drop in inches wg.
 - 4) Outdoor-air, wet- and dry-bulb temperatures in deg F.
 - 5) Return-air, wet- and dry-bulb temperatures in deg F.
 - 6) Entering-air, wet- and dry-bulb temperatures in deg F.
 - 7) Leaving-air, wet- and dry-bulb temperatures in deg F.
 - 8) Water flow rate in gpm).
 - 9) Water pressure differential in feet of head or psig.
 - 10) Entering-water temperature in deg F.
 - 11) Leaving-water temperature in deg F.
 - 12) Refrigerant expansion valve and refrigerant types.
 - 13) Refrigerant suction pressure in psig.
 - 14) Refrigerant suction temperature in deg F.
 - 15) Inlet steam pressure in psig.
6. Gas- and Oil-Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:
- a. Unit Data:
 - 1) System identification.
 - 2) Location.
 - 3) Make and type.
 - 4) Model number and unit size.
 - 5) Manufacturer's serial number.
 - 6) Fuel type in input data.
 - 7) Output capacity in Btu/h.
 - 8) Ignition type.
 - 9) Burner-control types.
 - 10) Motor horsepower and rpm.
 - 11) Motor volts, phase, and hertz.
 - 12) Motor full-load amperage and service factor.
 - 13) Sheave make, size in inches, and bore.

- 14) Center-to-center dimensions of sheave, and amount of adjustments in inches.
 - b. Test Data (Indicated and Actual Values):
 - 1) Total air flow rate in cfm.
 - 2) Entering-air temperature in deg F.
 - 3) Leaving-air temperature in deg F.
 - 4) Air temperature differential in deg F.
 - 5) Entering-air static pressure in inches wg .
 - 6) Leaving-air static pressure in inches wg.
 - 7) Air static-pressure differential in inches wg.
 - 8) Low-fire fuel input in Btu/hkW).
 - 9) High-fire fuel input in Btu/h.
 - 10) Manifold pressure in psig.
 - 11) High-temperature-limit setting in deg F.
 - 12) Operating set point in Btu/h.
 - 13) Motor voltage at each connection.
 - 14) Motor amperage for each phase.
 - 15) Heating value of fuel in Btu/h.
7. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:
 - a. Unit Data:
 - 1) System identification.
 - 2) Location.
 - 3) Coil identification.
 - 4) Capacity in Btu/h.
 - 5) Number of stages.
 - 6) Connected volts, phase, and hertz.
 - 7) Rated amperage.
 - 8) Air flow rate in cfm.
 - 9) Face area in sq. ft..
 - 10) Minimum face velocity in fpm.
 - b. Test Data (Indicated and Actual Values):
 - 1) Heat output in Btu/h.
 - 2) Air flow rate in cfm.
 - 3) Air velocity in fpm.
 - 4) Entering-air temperature in deg F.
 - 5) Leaving-air temperature in deg F.
 - 6) Voltage at each connection.
 - 7) Amperage for each phase.
8. Fan Test Reports: For supply, return, and exhaust fans, include the following:
 - a. Fan Data:
 - 1) System identification.
 - 2) Location.
 - 3) Make and type.
 - 4) Model number and size.
 - 5) Manufacturer's serial number.
 - 6) Arrangement and class.
 - 7) Sheave make, size in inches, and bore.
 - 8) Center-to-center dimensions of sheave, and amount of adjustments in inches.
 - b. Motor Data:
 - 1) Motor make, and frame type and size.
 - 2) Horsepower and rpm.

- 3) Volts, phase, and hertz.
- 4) Full-load amperage and service factor.
- 5) Sheave make, size in inches, and bore.
- 6) Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).
- 7) Number, make, and size of belts.
- c. Test Data (Indicated and Actual Values):
 - 1) Total airflow rate in cfm.
 - 2) Total system static pressure in inches wg.
 - 3) Fan rpm.
 - 4) Discharge static pressure in inches wg
 - 5) Suction static pressure in inches wg.
9. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
 - a. Report Data:
 - 1) System and air-handling-unit number.
 - 2) Location and zone.
 - 3) Traverse air temperature in deg F.
 - 4) Duct static pressure in inches wg.
 - 5) Duct size in inches.
 - 6) Duct area in sq. ft.
 - 7) Indicated air flow rate in cfm.
 - 8) Indicated velocity in fpm.
 - 9) Actual air flow rate in cfm.
 - 10) Actual average velocity in fpm.
 - 11) Barometric pressure in psig.
10. Air-Terminal-Device Reports:
 - a. Unit Data:
 - 1) System and air-handling unit identification.
 - 2) Location and zone.
 - 3) Apparatus used for test.
 - 4) Area served.
 - 5) Make.
 - 6) Number from system diagram.
 - 7) Type and model number.
 - 8) Size.
 - 9) Effective area in sq. ft.
 - b. Test Data (Indicated and Actual Values):
 - 1) Air flow rate in cfm .
 - 2) Air velocity in fpm .
 - 3) Preliminary air flow rate as needed in cfm.
 - 4) Preliminary velocity as needed in fpm.
 - 5) Final air flow rate in cfm.
 - 6) Final velocity in fpm.
 - 7) Space temperature in deg F.
11. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:
 - a. Unit Data:
 - 1) System and air-handling-unit identification.
 - 2) Location and zone.
 - 3) Room or riser served.

- 4) Coil make and size.
 - 5) Flowmeter type.
 - b. Test Data (Indicated and Actual Values):
 - 1) Air flow rate in cfm.
 - 2) Entering-water temperature in deg F.
 - 3) Leaving-water temperature in deg F.
 - 4) Water pressure drop in feet of head or psig.
 - 5) Entering-air temperature in deg F.
 - 6) Leaving-air temperature in deg F.
- 12. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:
 - a. Unit Data:
 - 1) Unit identification.
 - 2) Location.
 - 3) Service.
 - 4) Make and size.
 - 5) Model number and serial number.
 - 6) Water flow rate in gpm.
 - 7) Water pressure differential in feet of head or psig.
 - 8) Required net positive suction head in feet of head or psig.
 - 9) Pump rpm.
 - 10) Impeller diameter in inches.
 - 11) Motor make and frame size.
 - 12) Motor horsepower and rpm.
 - 13) Voltage at each connection.
 - 14) Amperage for each phase.
 - 15) Full-load amperage and service factor.
 - 16) Seal type.
 - b. Test Data (Indicated and Actual Values):
 - 1) Static head in feet of head or psig.
 - 2) Pump shutoff pressure in feet of head or psig.
 - 3) Actual impeller size in inches.
 - 4) Full-open flow rate in gpm.
 - 5) Full-open pressure in feet of head or psig.
 - 6) Final discharge pressure in feet of head or psig.
 - 7) Final suction pressure in feet of head or psig.
 - 8) Final total pressure in feet of head or psig.
 - 9) Final water flow rate in gpm.
 - 10) Voltage at each connection.
 - 11) Amperage for each phase.
- 13. Instrument Calibration Reports:
 - a. Report Data:
 - 1) Instrument type and make.
 - 2) Serial number.
 - 3) Application.
 - 4) Dates of use.
 - 5) Dates of calibration.
- 14. Sound Level Reports:
 - a. Location.
 - b. Octave bands - equipment off.
 - c. Octave bands - equipment on.

15. Vibration Tests:
 - a. Location of points:
 - 1) Fan bearing, drive end.
 - 2) Fan bearing, opposite end.
 - 3) Motor bearing, center (if applicable).
 - 4) Motor bearing, drive end.
 - 5) Motor bearing, opposite end.
 - 6) Casing (bottom or top).
 - 7) Casing (side).
 - 8) Duct after flexible connection (discharge).
 - 9) Duct after flexible connection (suction).
 - b. Test readings:
 - 1) Horizontal, velocity and displacement.
 - 2) Vertical, velocity and displacement.
 - 3) Axial, velocity and displacement.
 - c. Normally acceptable readings, velocity and acceleration.
 - d. Unusual conditions at time of test.
 - e. Vibration source (if non-complying).

3.31 INSPECTIONS

- A. Initial Inspection:
 1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.
 2. Check the following for each system:
 - a. Measure airflow of at least 10 percent of air outlets.
 - b. Measure water flow of at least 5 percent of terminals.
 - c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
 - d. Verify that balancing devices are marked with final balance position.
 - e. Note deviations from the Contract Documents in the final report.
- B. Final Inspection:
 1. After initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Architect.
 2. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of Architect.
 3. Architect shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
 4. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
 5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.
- C. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:
 1. Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.

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

D. Prepare test and inspection reports.

3.32 ADDITIONAL TESTS

- A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
- B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION

**SECTION 23 09 00
INSTRUMENTATION AND CONTROL FOR HVAC**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Control System
- B. BAS Equipment
- C. Local Control Units.
- D. Unitary Controllers.
- E. Alarm Panels
- F. Analog Controllers.
- G. Time Clocks.
- H. Electronic Sensors.
- I. Status Sensors and Devices – Electric.
- J. Occupancy, Daylighting, And Photo-Electric Sensors.
- K. Airflow Measuring Stations.
- L. Duct-Mounted Airflow Station.
- M. Flow Meters.
- N. DDC BTU Metering.
- O. Thermostats.
- P. Humidistats.
- Q. Actuators.
- R. Control Valves.
- S. Dampers.
- T. Air Supply.
- U. Control Cable.

1.02 GENERAL REFERENCES

1.03 REFERENCE STANDARDS

- A. ASHRAE 136 - A Method of Determining Air Change Rates in Detached Drawings; 2006.
- B. ASHRAE Std 135 - A Data Communication Protocol for Building Automation and Control Networks; 2020, with Addendum (2024).
- C. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2021.
- D. {RSTEMP#367}
- E. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings; 2004 (Reapproved 2023).
- F. ASTM A536 - Standard Specification for Ductile Iron Castings; 2024.
- G. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2022.
- H. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric); 2020.
- I. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service; 2023.
- J. ASTM D2737 - Standard Specification for Polyethylene (PE) Plastic Tubing; 2022.

- K. CEA-709.1 - Control Network Protocol Specification; 2012.
- L. CSA C22.1 - Canadian Electrical Code, Part I, Safety Standard for Electrical Installations; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- M. NEMA 12 - Enclosures for Electrical Equipment; 2020.
- N. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.
- O. NEMA TP 80049 - Safety Labels for Pad-Mounted Switchgear and Transformers Sited in Public Areas; 2025.
- P. NEMA BS 31032 - Residential Controls--Electrical Wall-Mounted Room Thermostats; 2025.
- Q. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- R. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2024.

1.04 PERFORMANCE REQUIREMENTS

- A. Comply with the following performance requirements:
 - 1. Graphic Display: Display graphic with minimum 30 dynamic points with current data within 5 seconds.
 - 2. Graphic Refresh: Update graphic with minimum 30 dynamic points with current data within 2 seconds.
 - 3. Object Command: Reaction time of less than two seconds between operator command of a binary object and device reaction.
 - 4. Object Scan: Transmit change of state and change of analog values to control units or workstation within six seconds.
 - 5. Alarm Response Time: Annunciate alarm at workstation within 15 seconds. Multiple workstations must receive alarms within five seconds of each other.
 - 6. Program Execution Frequency: Run capability of applications as often as five seconds, but selected consistent with mechanical process under control.
 - 7. Performance: Programmable controllers shall execute DDC PID control loops, and scan and update process values and outputs at least once per second.
 - 8. Reporting Accuracy and Stability of Control: Report values and maintain measured variables within tolerances as follows:
 - a. Water Temperature: Plus or minus 1 degree F (0.56 degrees C).
 - b. Water Flow: Plus or minus 5 percent of full scale.
 - c. Water Pressure: Plus or minus 2 percent of full scale.
 - d. Space Temperature: Plus or minus 1 degree F (0.56 degrees C).
 - e. Ducted Air Temperature: Plus or minus 1 degree F (0.56 degrees C).
 - f. Outside Air Temperature: Plus or minus 2 degrees F (1.1 degrees C).
 - g. Averaging Air Temperature: Plus or minus 2 degrees F (1.1 degrees C).
 - h. Dew Point Temperature: Plus or minus 2.7 degrees F (1.5 degrees C).
 - i. Temperature Differential: Plus or minus 0.27 degrees F (0.15 degrees C).
 - j. Relative Humidity: Plus or minus 5-percent relative humidity (% RH).
 - k. Airflow (Pressurized Spaces): Plus or minus 2-percent of full scale (% FS).
 - l. Airflow (Measuring Stations): Plus or minus 3-% FS.
 - m. Airflow (Terminal): Plus or minus 5-% FS.
 - n. Air Pressure (Space): Plus or minus 0.0005 inches wg (0.125 Pa).
 - o. Air Pressure (Ducts): Plus or minus 0.02 inches wg (5 Pa).
 - p. Carbon Monoxide: Plus or minus 1-part per million (ppm) CO.
 - q. Carbon Dioxide: Plus or minus 50-ppm CO₂.
 - r. Electrical: Plus or minus 2-percent of reading (volts/amps/watts).

1.05 SUBMITTALS

A. Action Submittals

1. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.
 - a. Building Automation System: Include technical data for operator workstation, operating system software, color graphics; editors for graphics, point database, and programming; software licensing, software updates during construction, and other third-party applications.
 - b. DDC System Hardware: Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for remote operator's terminal, operator display menus, interface equipment to BAS, DDC Controllers, Unitary Controllers, Application Specific Controllers (e.g. Air Terminal Controller), transducers/transmitters, sensors, control dampers, damper actuators, control valves, valve actuators, relays/switches, auxiliary control panels.
 - c. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.
2. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - a. Bill of materials of equipment indicating quantity, manufacturer, and model number.
 - b. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
3. Wiring Diagrams: Power, signal, and control wiring.
 - a. Details of control panel faces, including controls, instruments, and labeling.
 - b. Written description of sequence of operation.
 - c. Schedule of dampers including size, leakage, and flow characteristics.
 - 1) Coordinate dampers sizes with sheet metal and/or mechanical contractor before submitting.
 - d. Schedule of valves including flow characteristics.
 - e. Schedule of Terminal Equipment Controllers; e.g. air terminals, unit ventilators, etc.
 - f. DDC System Hardware:
 - 1) Wiring diagrams for control units with termination numbers.
 - 2) Schematic diagrams and floor plans for field sensors and control hardware.
 - 3) Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.
 - g. Control System Software: List of color graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule, and operator notations.
 - h. Controlled Systems:
 - 1) Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.
 - 2) Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.
 - 3) Written description of sequence of operation including schematic diagram.
 - 4) Points list.
4. Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with ASHRAE Std 135.
5. Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with LonWorks.
6. Software and Firmware Operational Documentation: Include the following:
 - a. Software operating and upgrade manuals
 - b. Program Software Backup: On a DVD (CD-ROM) complete with data files

- c. Device address list
 - d. Printout of software application and graphic screens
 - e. Software licenses required by and installed for DDC workstations and control systems
- 7. Software Upgrade Kit: For Owner to use in modifying software to suit future systems revisions or monitoring and control revisions.
- 8. Qualification Data:
 - a. Manufacturer's product line being submitted shall be in full production for at least two years.
 - b. Installer shall be factory trained and authorized in the installation, startup, check-out and commissioning of the manufacturer's product line being submitted. Installer's field personnel shall have at least three years' experience in the installation of DDC-style temperature control systems.
- 9. Field quality control test reports
- 10. Installing contractor's commissioning reports
 - a. Calibration records and list of set points.
- B. Operation and Maintenance Materials
 - 1. The control system Contractor shall provide and maintain on site working spare parts for the control system during the warranty period including DDC Controllers, power supplies, modules, sensors, floor level (subnet) devices, transformers, etc. The owner will be custodian of these spare parts and shall be authorized to utilize them in performing first level maintenance. The control contractor Contractor shall refurbish/replace spare parts in exchange for failed items.
 - 2. Data: For HVAC instrumentation and control system to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - a. Maintenance instructions and list of spare parts for each type of control device and the compressed air station.
 - b. Interconnection wiring diagrams with identified and numbered system components and devices.
 - c. Keyboard illustrations and step-by-step procedures indexed for each operator function.
 - d. Inspection period, cleaning methods, recommended cleaning materials, and calibration tolerances.
 - e. Calibration records and list of set points.

1.06 WARRANTIES

- A. The control system shall be guaranteed for a period of two years after final approval by the Owner. The guarantee shall be provided for a completely installed system, including all components, parts, and assemblies of the control system. The guarantee shall cover parts, materials, and labor to locate and correct any defects in materials or workmanship.
- B. The Contractor shall initiate the warranty period by formally transmitting to the Owner commencement notification of the period for the system and devices accepted. The warranty period begins when these devices are formally accepted by the Owner (refer to ACCEPTANCE PROCEDURE below).
- C. Contact information shall be provided for quick service engineering assistance concerning hardware and software problems. There shall be provisions made for getting manufacturer certified diagnostic and repair personnel on the scene quickly should the need arise. There shall also be a software expert familiar with the software of this machine who can be easily contacted.

- D. This system shall be inspected by the control system Contractor for a four-hour period once each quarter during the warranty period to run diagnostic tests and also provide maintenance instructions to the operating personnel.
- E. The control system Contractor shall give the Owner 24 hours prior notification of each maintenance trip during the contract guarantee period. In addition, the Contractor shall furnish the Owner and Engineer a written record of each maintenance trip, number of employees present, time involved and work accomplished.
- F. Owner shall be able to make changes to database, when prior database is stored on disk in case of error in change, without affecting or voiding warranty.

1.07 QUALITY ASSURANCE

- A. Installer Qualifications: Automatic control system manufacturer's authorized representative who is trained and approved for installation of system components required for this Project.
 - 1. All contractor controls personnel working on the project must have documented knowledge and a minimum of 2 years of DDC experience specifically with the control systems being installed in the project.
 - 2. The on-site installer must have demonstrated ability to control all project HVAC equipment using contractor installed, BACnet-compliant components in compliance with the project requirements.
 - 3. The contractor shall provide qualified on-site support for front-end graphics installation and commissioning.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70 , Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with ASHRAE Std 135 for DDC system components.

1.08 MOCK-UPS AND SAMPLES

- A. Samples for Initial Selection: For each color required, of each type of thermostat or sensor cover with factory-applied color finishes.
- B. Samples for Verification: For each color required, of each type of thermostat or sensor cover.

1.09 COORDINATION

- A. Coordinate location of thermostats, humidistats, DDC control sensors, and other exposed control sensors with plans and room details before installation.
- B. Coordinate equipment with Division 28 Section "Intrusion Detection" to achieve compatibility with equipment that interfaces with that system.
- C. Coordinate equipment with Division 28 Section "Access Control" to achieve compatibility with equipment that interfaces with that system.
- D. Coordinate equipment with Division 27 Section "Clock Systems" to achieve compatibility with equipment that interfaces with that system.
- E. Coordinate equipment with Division 28 Section "PLC Electronic Detention Monitoring and Control Systems" to achieve compatibility with equipment that interfaces with that system.
- F. Coordinate equipment with Division 26 Section "Network Lighting Controls" to achieve compatibility with equipment that interfaces with that system.
- G. Coordinate equipment with Division 28 Section "Fire Detection and Alarm" to achieve compatibility with equipment that interfaces with that system.
- H. Coordinate supply of conditioned electrical branch circuits for control units and operator workstation.
- I. Coordinate equipment with Division 26 Section "Electrical Power Monitoring and Control" to achieve compatibility of communication interfaces.

- J. Coordinate equipment with Division 26 Section "Panelboards" to achieve compatibility with starter coils and annunciation devices.
- K. Coordinate equipment with Division 26 Section "Motor-Control Centers" to achieve compatibility with motor starters and annunciation devices.
- L. Coordinate installation of control dampers, smoke dampers, HVAC equipment isolation dampers, and pipe-mounted sensors and instruments with the mechanical and/or plumbing contractor.
- M. Coordinate installation of duct, space, outdoor, or building static pressure sensors with the finished surfaces, installing contractor and the Architect prior to installation.
- N. Coordinate installation of any exterior wall or roof-mounted sensors, instruments, photocells, or controllers required for the temperature control system with the General Contractor and the Architect prior to installation.
- O. Coordinate the color selection process of any sensor or device intended to be mounted on finished surfaces with the Architect prior to installation.

1.10 DELIVERY, STORAGE AND HANDLING

- A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.
- B. System Software: Update to latest version of software at Project completion.

1.11 SUMMARY DESCRIPTION

- A. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.
 - 1. Provide Building Automation System (BAS) as shown in the contract documents and described herein.
 - 2. Provide interface to BAS via BACnet or LonTalk or Proprietary as shown in the contract documents and described herein.
 - 3. Provide DDC System as shown in the contract documents and described herein.
 - 4. Sequences modified as a result of start-up, checkout, fine tuning, and/or commissioning shall be resubmitted to the Architect for record.
 - 5. The installing contractor is responsible for and shall provide the integration of the DDC with the existing EMS, including (but not limited to):
 - a. Insuring that the new DDC Controllers shall interface to the existing EMS network. There are three levels of system architecture: a campus-wide Management Level Network (MLN) that is Ethernet based IP protocol, a high performance peer-to-peer Building Level Network (BLN), and an Application Specific Controller Floor Level Network (FLN). Access to all levels from the EMS appears transparent to the user when accessing data graphically or developing control programs.
 - b. The design of the new installation shall allow the existing controllers to co-exist with the newly installed controllers without the use of gateways or protocol converters.
 - c. New DDC Controllers shall be fully and readily accessible from existing graphical user workstations.
 - d. Providing communication wiring (cable) from the newly installed DDC controllers to the nearest existing controller or networked to the Owner's IT network drop.
 - e. If required for networking, a network interface controller including hardware and panel, software (or firmware), and coordinating electrical power (and UPS back-up if required by Owner) per the contract documents.
 - f. Providing expansion of and/or upgrading of any network panel software/firmware and/or memory size to accommodate the additional point database and communication traffic (bandwidth) caused by accessing information across the

network from the Owner's EMS for graphical display purposes. Inclusive with this is necessary memory or bandwidth for trend data collection.

- g. Coordination with the Owner's IT group in terms of their providing for the additional bandwidth requirements as a result of the installation.
- h. If not currently at the latest software release version, providing the latest EMS software upgrade to bring the system to the most current released version.

PART 2 PRODUCTS

2.01 CONTROL SYSTEM

- A. BAS and DDC
 - 1. Manufacturers:
 - a. Alerton.
 - b. American Auto-Matrix.
 - c. Automated Logic Corporation.
 - d. Delta Controls.
 - e. Honeywell International.
 - f. Johnson Controls.
 - g. KMC Controls.
 - h. Schneider Electric USA (includes Tour Anderson, Invensys, Andover Controls)
 - i. Siemens Building Technologies.
 - j. Staefa Control Systems Inc.
 - k. Trane.
- B. Stand-alone or Supplemental Controls
 - 1. Manufacturers:
 - a. Daikin. (McQuay International)
 - b. Functional Devices.
 - c. Heat-Timer Corporation.
 - d. KMC Controls.
 - e. Pneuline Controls.
 - f. Sauter Controls Corporation.
 - g. Solidyne Corp.
 - h. TCS/BASYS Controls.
 - i. Tekmar Control Systems.
 - j. Teletrol Systems Incorporated.
 - k. Temco Controls Ltd. USA.
 - l. Triangle MicroSystems Inc.
- C. Control system shall consist of sensors, indicators, dampers, damper actuators, valves, valve actuators, final control elements, interface equipment, other apparatuses and accessories to control mechanical systems.
- D. Control system shall consist of sensors, indicators, dampers, damper actuators, valves, valve actuators, final control elements, interface equipment, other apparatuses and accessories, and software connected to distributed controllers operating in multiuser, multitasking environment on token-passing network and programmed to control mechanical systems. An operator workstation permits interface with the network via dynamic color graphics with each mechanical system, building floor plan, and control device depicted by point-and-click graphics.
- E. Control system shall include the following:
 - 1. Building intrusion detection system specified in Division 28 Section "Intrusion Detection"
 - 2. Building clock control system specified in Division 27 Section "Clock Systems"
 - 3. Building lighting control system specified in Division 26 Section "Network Lighting Controls"
 - 4. Fire alarm system specified in Division 28 Section "Fire Detection and Alarm"

5. Interface to manufacturer-provided equipment controllers, specified in other Division 23 Sections.
6. Direct interface means to third-party controllers via DDC sub-LAN specified herein and/or LonTalk or BACnet interface; as required by the installing contractor for a complete and operational system.
7. Proprietary "gateway products" as shown on control drawings to provide fully functional sub-system control/point monitoring.

2.02 BAS EQUIPMENT

- A. Operator Workstation: One PC-based microcomputer(s) workstation-class (not residential-class) with Operating System software with minimum configuration as follows:
- B. Coordinate closely with Owner's IT staff especially if workstation will reside on the Owner's network.
 1. Motherboard: With 4 integrated USB 2.0 ports, integrated Intel Pro 10/100 (Ethernet), integrated audio, BIOS, and hardware monitoring.
 2. Processor: Intel Core i7; MHz.
 3. Random Access Memory: 8 GB minimum GB.
 4. Graphics: Video adapter 1280 x 1024 pixels, 32-bit color, 64-MB video memory, with TV out.
 5. Monitor: 22 inches (430 mm), 1280 x 1024 pixels, LCD color.
 6. Keyboard: QWERTY, 105 keys, (in ergonomic shape – customer preference).
 7. Hard-Disk Drive: 256 GB.
 8. DVD/RW Read/Write Drive: 16x8x16.
 9. Mouse: Two-button, center wheel, Three button optical.
 10. Retain UPS requirement based on customer needs.
 11. Uninterruptible Power Supply: 2 kVa.
 12. Revise next sentence, if not an IT integration project, then "provide firewall and virus protection software.
 13. Operating System: Microsoft Windows 7 Professional with high-speed Internet access. Coordinate firewall and virus protection software requirements with the Owner's IT staff for integration projects. If system is not integrated over the Owner's IT network or is using a proprietary network, provide stand-alone firewall and virus protection software.
 - a. ASHRAE Std 135 Compliance: Workstation shall use ASHRAE Std 135 protocol and communicate using ISO 8802-3 (Ethernet) data-link/physical layer protocol.
 - b. LonWorks Compliance: Control units shall use LonTalk protocol and communicate using EIA2/CEA-709.1 data-link/physical layer protocol.
 14. Printer: Black-and-white dot-matrix or inkjet as follows:
 - a. Print Head: 1200 x1200 dpi maximum resolution
 - b. Paper Handling: Tractor feed for dot-matrix or a minimum of 250 sheet trays
 - c. Print Speed: Minimum of 15 pages per minute
 15. Printer: Color inkjet type as follows:
 - a. Print Head: 4800 x 1200 dpi maximum resolution; optimized color resolution
 - b. Paper Handling: Minimum of 100 sheets
 - c. Print Speed: Minimum of 10 pages per minute in black/white and 5 pages per minute in color
 16. BAS Application Software:
 - a. I/O capability from operator station
 - b. System security for each operator via software password and access levels
 - c. Automatic system diagnostics; monitor system and report failures
 - d. Field DDC database creation (editing) and support

- e. Automatic and manual database save and restore.
- f. Automatic and manual database transfer to field panels
- g. Dynamic color graphic displays
- h. Up to 10 screen displays at once.
- i. Custom graphics generation (editing) and graphics library of HVAC equipment and symbols.
- j. Ability to print color graphic on a color printer
- k. DDC program creation (editing) and support.
- l. Automatic and manual database save and restore.
- m. Automatic and manual database transfer to field panels
- n. Time of Day Program (Scheduling)
- o. Includes override scheduling and holiday scheduling
- p. Automatic and manual database save and restore.
- q. Automatic and manual database transfer to field panels
- r. Alarm processing, messages, and reactions.
- s. Trend logs retrievable in spreadsheets and database programs.
- t. Alarm and event processing.
- u. Alarms shall "break-through" and provide audible annunciation (may be turned off)
- v. Object and property status and control.
- w. Automatic restart of field equipment on restoration of power.
- x. Data collection, reports, and logs. Include standard reports for the following:
- y. Current values of all objects.
- z. Current alarm summary.
- aa. Disabled objects.
- bb. Alarm lockout objects.
- cc. Logs.
- dd. Custom report development.
- ee. Utility and weather reports.
- ff. Workstation application editors for controllers and schedules.
- gg. Maintenance Management is very expensive. Check with Owner first.
- hh. Maintenance Management.
- 17. Custom Application Software:
 - a. English language oriented.
 - b. Full-screen character editor/programming environment.
 - c. Allow development of independently executing program modules with debugging/simulation capability.
 - d. Support conditional statements.
 - e. Support floating-point arithmetic with mathematic functions.
 - f. Contains predefined time variables.
- 18. Configure the workstation to restart automatically after a power failure when a UPS is not provided or present.
- C. Diagnostic Terminal Unit: Portable notebook-style, PC-based, microcomputer capable of accessing system data by connecting to system network with minimum configuration as follows:
 - 1. System: With one integrated USB 2.0 port, integrated Intel Pro 10/100 (Ethernet), integrated audio, bios, and hardware monitoring.
 - 2. Processor: Intel Core i3 , MHz.
 - 3. Random-Access Memory: 8 GB MB.
 - 4. Graphics: Video adapter, minimum 800 x 600 pixels, 64 MB video memory.
 - 5. Monitor: 17 inches (430 mm) LCD color.
 - 6. Keyboard: QWERTY 105 keys, (in ergonomic shape – customer preference).
 - 7. Hard-Disk Drive: 128 GB .

8. CD-ROM Read/Write Drive: 48x24x48 .
 9. Pointing Device: Touch pad or other internal device; or optical mouse if intended for desktop use.
 10. Software:
 - a. Provide laptop with Windows Operating System (OS) to comply with Owner's IT requirements for current and future support. Coordinate with the Owner representative.
 - b. Provide all software necessary, including 3rd party, to provide Owner access to HVAC and equipment controllers (DDC controllers, Unitary Controllers, Terminal Equipment Controllers, and Application Specific Controllers).
 11. Cables: Provide necessary cables (including proprietary) to connect laptop to each controller as required in the project.
- D. Direct Digital Control (DDC) Units: Modular, comprising processor board with programmable, nonvolatile, random-access memory; local operator access and display panel; integral interface equipment; and backup power source.
1. Units monitor or control each I/O point; process information; execute commands from other control units, devices, and operator stations; and download from or upload to operator workstation or diagnostic terminal unit.
 2. Stand-alone mode control functions operate regardless of network status. Functions include the following:
 - a. Global communications.
 - b. Discrete/digital, analog, and pulse I/O.
 - c. Monitoring, controlling, or addressing data points.
 - d. Software applications, scheduling, and alarm processing.
 - e. Testing and developing control algorithms without disrupting field hardware and controlled environment.
 3. Standard Application Programs:
 - a. Electric Control Programs: Demand limiting, duty cycling, automatic time scheduling, start/stop time optimization.
 - b. HVAC Control Programs: Night setback/setup, on-off control with differential sequencing, staggered start, equipment lead/lag sequencing, anti-short cycling control, PID control, DDC with fine loop tuning, optimal run time, supply air reset, static pressure reset, and dry bulb/enthalpy economizer.
 - c. Chiller Control Programs: Control function of condenser water reset, chilled water reset, and equipment lead/lag sequencing.
 - d. Programming Application Features: Include trend point; alarm processing and messaging; weekly, monthly, and annual scheduling; energy calculations; run time totalization; and security access.
 - e. Remote communications.
 - f. Maintenance management.
 - g. Units of Measure: Inch-pound and SI (metric).
 4. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.
 5. ASHRAE Std 135 Compliance: Control units shall use ASHRAE Std 135 protocol and communicate using ISO 8802-3 (Ethernet) data-link/physical layer protocol.
 6. LonWorks Compliance: Control units shall use LonTalk protocol and communicate using EIA/CEA-709.1 data-link/physical layer protocol.
 7. Enclosure:
 - a. Indoor - Dustproof rated for operation at 32 to 120 degrees F (0 to 50 degrees C).
 8. I/O Interface: Hardwired inputs and outputs may tie into system through controllers. Protect points so that shorting will cause no damage to controllers.
 - a. Binary Inputs: Allow monitoring of on-off signals without external power.

- b. Pulse Accumulation Inputs: Accept up to 10 pulses per second.
- c. Analog Inputs: Allow monitoring of low-voltage (0- to 10-V dc), current (4- to 20-mA), or resistance signals.
- d. Binary Outputs: Provide on-off or pulsed low-voltage signal, selectable for normally open or normally closed operation with three-position (on-off-auto) override switches and status lights.
- e. Analog Outputs: Provide modulating signal, either low voltage (0- to 10-V dc) or current (4- to 20-mA) or resistance (0- to 135-ohms) with status lights, two-position (auto-manual) switch, and manually adjustable potentiometer.
- f. Tri-State Outputs: Provide two coordinated binary outputs for control of three-point, floating-type electronic actuators.
- g. Universal I/O's: Provide software selectable binary or analog outputs.
- 9. Power Supplies: Transformers with Class 2 current-limiting type or overcurrent protection; limit connected loads to 80 percent of rated capacity. DC power supply shall match output current and voltage requirements and be full-wave rectifier type with the following:
 - a. Output ripple of 5.0 mV maximum peak-to-peak.
 - b. Combined 1 percent line and load regulation with 100-microsecond response time for 50 percent load changes.
 - c. Built-in overvoltage and overcurrent protection and be able to withstand 150 percent overload for at least 3 seconds without failure.
- 10. Power Line Filtering: Internal or external transient voltage and surge suppression for workstations or controllers with the following:
 - a. Minimum dielectric strength of 1000-V.
 - b. Maximum response time of 10 nanoseconds.
 - c. Minimum transverse-mode noise attenuation of 65-dB.
 - d. Minimum common-mode noise attenuation of 150-dB at 40- to 100-Hz.

2.03 LOCAL CONTROL UNITS

- A. Modular, comprising processor board with electronically programmable, non-volatile, read-only memory; and backup power source.
- B. Units monitor or control each I/O point, process information, and download from or upload to operator workstation or diagnostic terminal unit.
- C. All other controller attributes match the DDC controller.
- D. Stand-alone mode control functions operate regardless of network status. Functions include the following:
 - 1. Global communications.
 - 2. Discrete/digital, analog, and pulse I/O.
 - 3. Monitoring, controlling, or addressing data points.
- E. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.
- F. ASHRAE Std 135 Compliance: Control units shall use ASHRAE Std 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.
- G. LonWorks Compliance: Control units shall use LonTalk protocol and communicate using EIA/CEA-709.1 datalink/physical layer protocol.
- H. Enclosure:
 - 1. Indoor - Dustproof rated for operation at 32 to 120 degrees F (0 to 50 degrees C).

2.04 UNITARY CONTROLLERS

- A. Controllers shall be provided for (but not limited to) Unit Ventilators, Fan Coils Units, Heat Pumps, etc.

- B. Unitized, capable of stand-alone operation with sufficient memory to support its operating system, database, and programming requirements, and with sufficient I/O capacity for the application.
 - 1. Configuration: Local keypad and display; diagnostic LEDs for power, communication, and processor; wiring termination to terminal strip or card connected with ribbon cable; memory with bios; and 72-hour battery backup.
 - 2. I/O Interface: Hardwired inputs and outputs into system through controller
 - 3. Operating System: Manage I/O communication to allow distributed controllers to share real and virtual object information and allow central monitoring and alarms. Perform scheduling with real-time clock.
 - 4. Perform automatic controller diagnostics; monitor controller and report failures.
 - 5. ASHRAE 136.
 - 6. LonWorks Compliance: Communicate using EIA/CEA-709.1 data-link/physical layer protocol using LonTalk protocol.
 - 7. Enclosure:
 - a. Indoor - Dustproof rated for operation at 32 to 120 degrees F (0 to 50 degrees C).
 - b. Outdoor - Weatherproof rated for operation at minus 10 to 150 degrees F (minus 23 to 65 degrees C).
- C. Air Terminal Unit Equipment Controllers (TEC)
 - 1. Variable Air Volume (VAV) and Constant Air Volume (CAV). CAV are indicated when minimum and maximum design cfm's are scheduled the same.
 - 2. Other equipment controllers that are similar are Series Fan-Powered and Parallel Fan-Powered VAV Terminals, and dual-duct air terminals.
 - 3. Modular construction, comprising processor board with programmable, nonvolatile, random access memory; and integral interface equipment.
 - 4. Units execute commands from DDC control units and download from or upload to diagnostic terminal unit.
 - 5. Controllers shall operate in stand-alone mode and control functions operate regardless of BACnet status. Functions include the following:
 - a. BACnet communications
 - b. Discrete digital input/outputs and analog input/out
 - c. Hardware for sensing air flow from flow measuring device
 - d. Monitoring and controlling points
 - e. HVAC software application programs that are application specific (e.g. VAV) and alarm processing
 - f. Terminal port for program selection, addressing, air balance, and firmware updates.
 - 6. Application Specific Programs:
 - a. VAV and CAV air terminal control algorithms as needed to perform the sequences on the drawings.
 - b. Series and Parallel Fan-Powered air terminal control algorithms as needed to perform the sequences on the drawings.
 - c. Dual-duct air terminal control algorithms as needed to perform the sequences on the drawings.
 - 7. Units of Measure: Inch-Pound
 - 8. Remote communications to DDC Controllers.
 - 9. Local terminal plug for field service and air balancer use. Provide air balance subcontractor with software necessary for air balance work.
 - 10. In a proprietary system, protocol compliance is based on the DDC manufacturer's choice. Delete next sentence if not applicable.
 - 11. Protocol Compliance: Control units shall communicate using existing BACnet protocol.
 - 12. I/O Interface: Hardwired inputs and outputs may tie into system through controllers. Protect points so that shorting will cause no damage to controllers.

- a. Binary Inputs: Allow monitoring of on-off signals without external power.
- b. Pulse Accumulation Inputs: Accept up to 10 pulses per second.
- c. Analog Inputs: Allow monitoring of low-voltage (0- to 10-V dc), current (4- to 20-mA), or resistance signals.
- d. Binary Outputs: Provide on-off or pulsed low-voltage signal, selectable for normally open or normally closed operation with three-position (on-off-auto) override switches and status lights.
- e. Analog Outputs: Provide modulating signal, low voltage (0- to 10-V dc) or current (4- to 20-mA); with status lights, two-position (auto-manual) switch, and manually adjustable potentiometer or selector switch.
- f. Tri-State Outputs: Provide two coordinated binary outputs for control of three-point, floating-type electronic actuators.
- g. Universal I/O's (optional as needed): Provide software selectable binary or analog outputs.
- h. Airflow probed connections for sensing airflow through terminal.
- 13. Power Supply: Class 2 transformers located in DDC Auxiliary Panel shall provide 24 VAC (current-limited) with fuse protection to TEC's.
- 14. Power Line Filtering: Transient voltage and surge suppression for controllers.
- 15. Enclosure:
 - a. Indoor – Dust-proof rated for operation at 32 to 120 degrees F (0 to 50 degrees C).

2.05 ALARM PANELS

- A. Unitized cabinet with suitable brackets for wall or floor mounting. Fabricated 0.06 inch (1.5 mm) thick, furniture-quality steel or extruded-aluminum alloy, totally enclosed, with hinged doors and keyed lock and with manufacturer's standard shop-painted finish. Provide common keying for all panels.
- B. Indicating light for each alarm point, single horn, acknowledge switch, and test switch, mounted on hinged cover.
 - 1. Alarm Condition: Indicating light flashes and horn sounds.
 - 2. Acknowledge Switch: Horn is silent and indicating light is steady.
 - 3. Second Alarm: Horn sounds and indicating light is steady.
 - 4. Alarm Condition Cleared: System is reset and indicating light is extinguished.
 - 5. Contacts in alarm panel allow remote monitoring by independent alarm company.

2.06 ANALOG CONTROLLERS

- A. Step Controllers: 6- or 10-stage type, with heavy-duty switching rated to handle loads and operated by electric motor.
- B. Electric, Outdoor-Reset Controllers: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range, adjustable setpoint, scale range minus minus 10 to 70 degrees F (minus 23 to 21 degrees C), and single or double pole contacts.
- C. Electronic Controllers: Wheatstone-bridge-amplifier type, in steel enclosure with provision for remote-resistance readjustment. Identify adjustments on controllers, including proportional band and authority.
 - 1. Single controllers can be integral with control motor if provided with accessible control readjustment potentiometer.
- D. Fan Speed Controllers: Solid-state model providing field-adjustable proportional control of motor speed from maximum to minimum of 55 percent and on-off action below minimum fan speed. To bring motor up to minimum speed rapidly, controller shall briefly apply full voltage when starting motor. Equip with filtered circuit to eliminate radio interference.
- E. Receiver Controllers: Single- or multiple-input models with control point adjustment, direct or reverse acting with mechanical Setpoint adjustment with locking device, proportional band adjustment, authority adjustment, and proportional control mode.

1. Remote-control-point adjustment shall be plus or minus 20 percent of sensor span, input signal of 3 to 15 psig (21 to 103 kPa).
2. Proportional band shall extend from 2- to 20-percent for 5 psig (34 kPa).
3. Authority shall be 20- to 200-percent.
4. Air supply pressure of 25 psig (172 kPa), input signal of 3 to 15 psig (21 to 103 kPa), and output signal of zero to supply pressure.
5. Gages: 1-1/2 inches (38 mm) in diameter, 2.5 percent full-scale accuracy, marked in psig (kPa), and ranged to match transmitter input or output pressure.

2.07 TIME CLOCKS

- A. Manufacturers:
 1. ATC-Diversified Electronics.
 2. Grasslin Controls Corporation.
 3. Paragon Electric Co.
 4. Precision Multiple Controls.
 5. SSAC Inc.
 6. TCS/Basys Controls.
 7. Theben AG - Lumilite Control Technology.
 8. Time Mark Corporation.
- B. Seven-day, programming-switch timer with synchronous timing motor and seven-day dial; continuously charged, nickel-cadmium-battery-driven, eight-hour, power-failure carryover; multiple-switch trippers; minimum of two and maximum of eight signals per day with two normally open and two normally closed output contacts.
- C. Solid-state, programmable time control with 4 separate programs each with up to 100 on-off operations; 1-second resolution; lithium battery backup; keyboard interface and manual override; individual on-off-auto switches for each program; 365-day calendar with 20 programmable holidays; choice of fail-safe operation for each program; system fault alarm; and communications package allowing networking of time controls and programming from PC.

2.08 ELECTRONIC SENSORS

- A. Description
 1. Vibration and corrosion resistant, for wall, immersion, or duct mounting as required.
 2. All sensors provided with a guard or cover shall submit color samples to the Architect before ordering sensors.
 3. Room Sensor Cover Construction: Manufacturer's standard locking covers. This applies to all wall mounted sensors.
 - a. Color: Submit color selection to Architect prior to ordering.
 - b. Orientation: Vertical.
 - c. Appearance: Flush.
 - d. Housing: Metal.
 4. Room sensor accessories include the following:
 - a. Insulating Base: For sensors located on exterior walls and cold surfaces.
 - b. Guard: Locking; heavy-duty transparent plastic; mounted on separate base.
 - c. Adjusting Device: As required for calibration and cover screws.
- B. Air Terminal Equipment Room Sensor
 1. Manufacturers:
 - a. Siemens Building Technologies.
 - b. Johnson Controls.
 2. Sensor:
 - a. See Thermistor and RTD below.
 3. Wiring requirement: Twisted, shielded-pair cable or pre-manufactured cables with terminations matched to the controller.

4. Room Sensor Cover Construction: Manufacturer's standard locking covers. Include the following with those listed above.
 - a. Electronic display: LCD (temperature)
 - b. Setpoint Adjustment: Concealed.
 - c. Setpoint Indication: Exposed.
 - d. Pushbutton for override: Required.
- C. Thermistors
 1. Manufacturers:
 - a. MINCO.
 - b. MAMAC Systems.
 - c. RDF Corporation.
 2. Sensor type and accuracy:
 - a. Negative temperature coefficient (NTC) sensor with 10K-ohms or less resistance.
 3. Wiring requirement: Twisted, shielded-pair cable.
 4. Accuracy: Plus or minus 0.5 degrees F (0.3 degrees C) at calibration point.
 5. Wiring requirement: Twisted, shielded-pair cable.
 6. Insertion Elements in Ducts: Single point, 8 inches (200 mm) long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft (0.84 sq. m).
 7. Averaging Elements in Ducts: 36 inches (914 mm) long, flexible use where prone to temperature stratification or where ducts are larger than 10 sq. ft (1 sq. m).
 8. Insertion Elements for Liquids: Brass well (for copper, brass, or plastic pipe) with minimum insertion length of 2-1/2 inches (64 mm). Stainless steel well for ferrous pipe.
 9. Outside Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
 10. Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.
- D. RTD and Transmitters
 1. Manufacturers:
 - a. MINCO.
 - b. MAMAC Systems.
 - c. RDF Corporation.
 2. Sensor element:
 - a. Platinum.
 - b. Nickel.
 3. Accuracy: Plus or minus 0.5 degrees F (0.3 degrees C) at calibration point.
 4. Wiring requirement: Twisted, shielded-pair cable.
 5. Insertion Elements in Ducts: Single point, 8 inches (200 mm) long; use where not affected by temperature stratification or where ducts are smaller than 9-sq. ft. (0.84-sq. m)).
 6. Averaging Elements in Ducts: 18 inches (460 mm) long, rigid use where prone to temperature stratification or where ducts are larger than 9 sq. ft (0.84 sq. m); length as required.
 7. Insertion Elements for Liquids: Brass well (for copper or brass pipe) with minimum insertion length of 2-1/2 inches (64 mm). Stainless steel well for ferrous pipe.
 8. Outside Air Sensors: Watertight, electrical inlet fitting; sensors are shielded from direct sunlight.
 9. Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.
 10. Transmitter output shall be 4- to 20-mA, nominal 24-V dc. Output impedance must meet DDC input requirements.
- E. Humidity
 1. Manufacturers:
 - a. General Electric. (General Eastern Instruments)

- b. MAMAC Systems.
 - c. ROTRONIC Instrument Corp.
 - d. TCS/Basys Controls.
 - e. Vaisala.
 - 2. Sensor: Bulk polymer sensor element
 - 3. Accuracy: 5 % RH with linear output.
 - 4. Wiring requirement: Twisted, shielded-pair cable.
 - 5. Room Sensor Range: 5- to 95-% RH.
 - 6. Room Sensor Cover Construction: Manufacturer's standard locking covers.
 - a. Setpoint Adjustment: Controlled through DDC controller
 - b. Display: Concealed, LED.
 - c. Color: _____.
 - d. Orientation: Vertical.
 - 7. Duct Sensor Range: 5- to 95-% RH with element guard and mounting plate.
 - 8. Outside Air Sensor Range: 5- to 95-% RH with mounting enclosure/sunshield, suitable for operation at outdoor temperatures of 32 to 120 degrees F (0 to 50 degrees C).
 - 9. Transmitter output shall be 4- to 20-mA, nominal 24-V dc. Output impedance must meet DDC input requirements.
- F. Pressure Transmitters/Transducers
- 1. Manufacturers:
 - a. BEC Controls.
 - b. General Electric. (General Eastern Instruments)
 - c. MAMAC Systems.
 - d. Rotronic Instrument Corp.
 - e. Setra Systems.
 - f. TCS/Basys Controls.
 - g. Vaisala.
 - 2. Sensors: Appropriate sensing chamber for medium being sensed.
 - 3. Wiring requirement: twisted, shielded-pair cable for wiring unless specified otherwise by the manufacturer.
 - 4. Air Static Pressure Transmitter: Non-directional sensor with suitable range for expected input, and temperature compensated.
 - a. Accuracy: 2-% full scale with repeatability of 0.5 percent.
 - b. Output: 4- to 20-mA. Output impedance must meet input requirements.
 - c. Building Static Pressure Range: Minus 0.05 to 0.05 inches wg (Minus 12 to 12 Pa).
 - d. Duct Static Pressure Range: 0 to 2.5 inches wg (0 to 623 Pa).
 - 5. Hydronic Pressure Transducers: Stainless steel diaphragm construction, suitable for service; minimum 150 psig (1034 kPa) operating pressure; linear output.
 - a. Accuracy: 2-% FS scale reading with repeatability of 0.5-% FS
 - b. Output: 4- to 20-mA, nominal 24-V dc. Output impedance must meet input requirements.
 - c. Range: 0 to 60 psig (0 to 414 kPa).
 - 6. Hydronic Differential Pressure Transducers: Stainless steel diaphragm construction, suitable for service; minimum 150 psig (1034 kPa) operating pressure and tested to 300 psig (2068 kPa); linear output. Provide 3-valve manifold with instrument.
 - a. Accuracy: 1-% FS overall accuracy: includes sensor accuracy, linearity, hysteresis, and non-repeatability.
 - b. Output: 4- to 20-mA, nominal 24-V dc, loop- powered. Output impedance must meet DDC input requirements.
 - c. Range: 0 to 60 psig (0 to 414 kPa).
 - 7. Air Differential Pressure Switch: Snap acting, pilot-duty rated contact, and with suitable scale range and setting adjustment.

- a. SPDT or DPDT, dry contact style device
- b. Range: Adjustable from 1- to 10- inches wg
- c. Differential: Adjustable from 2-psig to 10-psig
- 8. Air Differential Pressure Switch: Snap acting, pilot-duty rated contact, and with suitable scale range and setting adjustment.
 - a. SPDT or DPDT, dry contact style device
 - b. Range: Adjustable from 1 to 10 inches wg (249 to 2490 Pa).
 - c. Differential: Adjustable from 0.1 to 0.25 inches wg (25 to 62 Pa).
- 9. Process Pressure and Differential Pressure Transmitters: Direct acting for gas or steam service; range suitable for system; linear output.
 - a. Accuracy: 1-% FS with repeatability of 0.5-% FS.
 - b. Output: 4- to 20-mA, nominal 24-V dc, loop-powered. Output impedance must meet DDC input requirements.
 - c. Air Pressure Range: 0 to 100 psig (0 to 68 kPa).
 - d. Velocity Pressure Range: 0 to 0.5 inches wg (0 to 125 Pa).
 - e. Add vacuum pressure sensors if required in project.

2.09 STATUS SENSORS AND DEVICES - ELECTRIC

- A. Status Input for Fan: Differential pressure switch with pilot-duty rated contacts and adjustable range of 0 to 5 inch wg (0 to 1245 Pa).
 - 1. Manufacturers:
 - a. Cleveland Controls.
- B. Status Input for Pump: Liquid differential pressure switch with pilot-duty rated contacts and adjustable pressure range of 20 to 60 psig (138 to 414 kPa) and differential pressure range of 5 to 30 psig (34 to 207 kPa), SPDT contacts pilot-duty rated or for application, 1/4" female NPT pipe connections.
 - 1. Manufacturers:
 - a. United Electric Controls.
- C. Sensing Inputs for Electric Motors:
 - 1. Manufacturers:
 - a. American Aerospace Controls.
 - 2. Current Transformer/Transmitter: Comply with ISA 50.00.01, current-sensing, fixed- or split-core transformers with self-powered transmitter, adjustable and suitable for 175 percent of rated motor current and 1 percent full-scale accuracy, for AC or DC applications.
 - 3. Voltage Transformer/Transmitter (100- to 600-V AC): Comply with ISA 50.00.01, single-loop, self-powered transmitter, adjustable, with suitable range and 1 percent full-scale accuracy, for AC or DC applications.
 - 4. Power Monitor: 3-phase type with disconnect/shorting switch assembly, listed voltage and current transformers, with pulse kilowatt hour output and 4- to 20-mA kW output, with maximum 2 percent error at 1.0 power factor and 2.5 percent error at 0.5 power factor, for AC and DC applications.
- D. Current Switch: Self-powered, current-sensing, split-core, solid-state devices with adjustable trip current and indicating LED, selected to match motor current and DDC input requirements.
 - 1. Manufacturers:
 - a. Nielsen-Kuljian.
 - b. Veris Industries.
- E. Electronic Valve/Damper Position Indicator: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.
 - 1. Manufacturers:
 - a. DDC equipment manufacturer's recommended product

- F. Water Flow Switch: Bellows-actuated mercury or snap-acting type with pilot-duty rating, stainless-steel or bronze paddle, with appropriate range and differential adjustment, in NEMA EN 10250, Type 1 enclosure.
 - 1. Manufacturers:
 - a. Xylem.
 - b. I.T.M. Instruments.
- G. Liquid Leak Detectors
 - 1. Liquid detectors shall utilize microchip technology for detection of conductive liquids through one of the following types of sensors: gold-plated probes, self-adhesive sensor tape with copper electrodes and durable cotton cover, or rope type sensor. Detectors shall be selected based on the best use for the application. Power requirement shall be 11-27 VAC or VDC and have a green LED normal operation indicator. Unit shall have a SPDT pilot duty low voltage alarm contact. Unit shall be waterproof and rustproof. A red LED shall indicate the presence of liquid. Unit shall have an adjustable setpoint.
 - 2. Manufacturers:
 - a. R. E. Technologies.
 - b. Dorlen Products. (Water Alert)
- H. Control Relay: Monitors or controls AC or DC motors or other equipment (as required), with cover, with visual indicator when energized, and two SPDT contacts rated 120/250 VAC at 8 Amps.
 - 1. Manufacturers:
 - a. Dayton.
 - b. Omron.
 - c. Functional Devices.
- I. Damper End Switch (limit switch): Fully encapsulated, mercury-type, damper end switch with two contacts per switch; one for interlock wiring and one for DDC input.
 - 1. Manufacturers:
 - a. KELE Controls part number TS-470-2.
- J. Emergency Power-Off (EPO) Push-button: ADA compliant, push-button switch with clear cover to prevent inadvertent closure. Push-to-activate push-button, key-to-reset feature, and providing two SPDT contacts rated 120/250 VAC at 10 Amps.
 - 1. Manufacturers:
 - a. Safety Technology International – model SS-2212PO.
- K. Boiler EPO Contactor: Electrically operated, electrically held; provide contactor in NEMA 12 rated enclosure. Six (6) normally closed contacts rated 120/250 VAC at 20 Amps.
 - 1. Manufacturers:
 - a. Allen-Bradley.
 - b. Cutler-Hammer.
 - c. Square-D.

2.10 OCCUPANCY, DAYLIGHTING, AND PHOTO-ELECTRIC SENSORS

- A. Refer to Division 26 Section "Lighting Control Devices" for equipment that relates to this Section.

2.11 FLOW METERS

2.12 DDC BTU METERING

- A. DDC BTU metering shall be accomplished using the following equipment at each metering point:
 - 1. One (1) liquid flow meter unit with current-loop transmitter as specified elsewhere in this section.
 - a. Flow meter range shall be 125% of the maximum expected flow capacity.

2. Two (2) high-precision matched temperature sensor assemblies with current-loop transmitters. Sensors with stainless steel wells shall be installed in each respective supply and return pipe as shown on project drawings for ferrous piping (use copper or brass wells for copper piping).
 - a. Manufacturers: MINCO and TCS
 - b. Temperature sensors shall be a matched pair selected for this application.
 - c. Temperature sensor accuracy shall be plus or minus 0.1-F (0.05-C) at calibration temperature. Calibration temperature for chilled water is 44.0-F (6.7-C) and for heating hot water is 180.0-F (82.2-C)
3. These devices shall be wired to a local DDC panel. Calculations for instantaneous and totalized load shall be incorporated into the panel control code, and the necessary virtual points shall be created to allow remote monitoring and trending via the DDC system.
- B. DDC shall perform BTU computations using linear, square law, or multi-point linearization data interpretation, as needed, based on the flow meter used. Inputs shall include:
 1. 4- to 20-ma signal from hydronic flow meter
 2. 4- to 20-ma signal from two, high-accuracy, immersion temperature sensors
- C. Input devices shall be rated for the environment in which they are installed. DDC shall perform rate of flow calculations as well as monitor the flow and totalize it weekly, monthly, and yearly. These values shall be available at the BAS in graphical format for operator monitoring. Flow rate alarms shall be programmed for low flow and high flow conditions.
- D. Provide an equipment tag for each transmitter device to identify service and ID number (i.e. CHILLED WATER BTU METER – ANNEX BUILDING, etc.).

2.13 THERMOSTATS

- A. Manufacturers:
 1. Danfoss Inc.
 2. Erie Controls.
 3. Heat-Timer Corporation.
 4. Sauter Controls Corporation.
 5. Tekmar Control Systems.
 6. Theben AG - Lumilite Control Technology.
- B. Combination Thermostat and Fan Switches: Line-voltage thermostat with push-button or lever-operated fan switch.
 1. Label switches FAN ON-OFF
 2. Mount on single electric switch box.
- C. Electric, solid-state, microcomputer-based room thermostat with remote sensor.
 1. Automatic switching from heating to cooling
 2. Preferential rate control to minimize overshoot and deviation from setpoint
 3. Capable of providing four separate temperatures per day
 4. Instant override of setpoint for continuous or timed period from 1 hour to 31 days.
 5. Short-cycle protection.
 6. Programming based on weekday, Saturday, and Sunday
 7. Selection features include degree F or degree C display, keyboard disable, remote sensor, and fan on-auto.
 8. Battery replacement without program loss.
 9. Thermostat display features include the following:
 - a. Time of the day
 - b. Actual room temperature
 - c. Programmed temperature setpoints
 - d. Programmed time for occupied/unoccupied
 - e. Duration of timed override

- f. Day of week
 - g. System mode indications include "heating," "off," "fan auto," and "fan on."
- D. Low-Voltage, On-Off Thermostats: NEMA BS 31032, 24-V, bimetal-operated, mercury-switch type, with adjustable or fixed anticipation heater, concealed setpoint adjustment 55- to 85 F (13- to 30 C) setpoint range, and 2 F (1 C) maximum differential.
- E. Line-Voltage, On-Off Thermostats: Bimetal-actuated, open contact or bellows-actuated, enclosed, snap-switch or equivalent solid-state type, with heat anticipator; listed for electrical rating; with concealed setpoint adjustment, 55- to 85 F (13- to 30 C) setpoint range, and) 2 F (1 C) maximum differential.
 - 1. Electric Heating Thermostats: Equip with off position on dial wired to break ungrounded conductors.
 - 2. Selector Switch: Integral, manual, On-Off-Auto.
- F. Remote-Bulb Thermostats: On-off or modulating type, liquid filled to compensate for changes in ambient temperature; with copper capillary and bulb, unless otherwise indicated.
 - 1. Bulbs in water lines with separate wells of same material as bulb.
 - 2. Bulbs in air ducts with flanges and shields.
 - 3. Averaging Elements: Copper tubing with either single- or multiple-unit elements, extended to cover full width of duct or unit; adequately supported.
 - 4. Scale settings and differential settings are clearly visible and adjustable from front of instrument.
 - 5. On-Off Thermostat: With precision snap switches and with electrical ratings required by application.
 - 6. Modulating Thermostats: Construct so complete potentiometer coil and wiper assembly is removable for inspection or replacement without disturbing calibration of instrument.
- G. Fire-Protection Thermostats: Listed and labeled by an nationally recognized testing laboratory (NRTL) acceptable to authority's having jurisdiction; with fixed or adjustable settings to operate at not less than 75-degrees F (24-degrees C) above normal maximum operating temperature, and the following:
 - 1. Reset: Manual only
 - 2. Reset: Automatic, with control circuit arranged to require manual reset at central control panel; with pilot light and reset switch on panel labeled to indicate operation.
- H. Pneumatic Room Thermostats: one pipe(s), fully proportional with adjustable throttling range and tamperproof locking settings, direct or reverse acting as required.
 - 1. Factory Calibration: .2.5 F (31.0- C)
 - 2. Range: .45- to 85 F (7- to 29 C)
 - 3. Sensitivity Adjustment Range: .1- to 4 F (12.4- to 49.6-kPa C)
 - 4. Dual-Temperature Thermostats: Automatic changeover from normal setting to lower setting for unoccupied cycles, with manual-reset lever to permit return to normal temperatures during unoccupied cycles, with automatic reset to normal during next cycle of operation.
 - 5. Limits: Field adjustable, to limit setting cooling setpoint above 74-F (23-C) and heating setpoint below 72-F (22-C)
 - 6. Room Thermostat Cover Construction: Manufacturer's standard locking covers.
 - a. Setpoint Adjustment:
 - b. Setpoint Indication: Concealed
 - c. Thermometer: Concealed
 - d. Color: _____.
 - e. Orientation: Vertical
 - 7. Room thermostat accessories include the following:
 - a. Insulated Base: For thermostats located on exterior walls.

- b. Thermostat Guards: Locking; heavy-duty, transparent plastic; mounted on separate base
 - c. Adjusting Key: As required for calibration and cover screws.
 - d. Aspirating Boxes: For flush-mounted aspirating thermostats.
 - e. Setpoint Adjustment: 1/2 inch (13 mm) diameter, adjustment knob.
- I. Immersion Thermostat: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range and adjustable setpoint.
- J. Airstream Thermostats: Two-pipe, fully proportional, single-temperature type; with adjustable setpoint in middle of range, adjustable throttling range, plug-in test fitting or permanent pressure gage, remote bulb, bimetal rod and tube, or averaging element.
- K. Electric, Low-Limit, Duct Thermostat (Freezestat): Snap-acting, single-pole, single-throw, manual-reset-only switch, that trips when the air temperature sensed across any 12 inches (300 mm) of capillary length is equal to or below setpoint, concealed setpoint adjustment for low and high setting, and provides 15- to 55-degrees F (minus 9- to 13-degrees C) setpoint range and fixed differential.
 - 1. Bulb Length: Minimum 20 feet (6 m).
 - 2. Quantity: One thermostat for every 20-sq. ft. (2-sq. m.) of coil surface.
- L. Electric, High-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual- or automatic- reset switch that trips if temperature sensed across any 12-inches (300-mm) of bulb length is equal to or above setpoint.
 - 1. Bulb Length: Minimum 20 feet (6 m).
 - 2. Quantity: One thermostat for every 20 sq. ft (2 sq. m) of coil surface.
- M. Heating/Cooling Valve-Top Thermostats: Proportional acting for proportional flow, with molded-rubber diaphragm, remote-bulb liquid-filled element, direct and reverse acting at minimum shutoff pressure of 25 psig (172 kPa), and cast housing with position indicator and adjusting knob.

2.14 HUMIDISTATS

- A. Manufacturers:
 - 1. MAMAC Systems.
 - 2. Rotronic Instrument Corp.
- B. Pneumatic:
 - 1. Room Humidistats: Wall-mounting, proportioning type with adjustable throttling range, 20 to 90 percent relative humidity (RH) operating range, and cover matching room thermostat cover. Calibrated for +/- 5% RH accuracy.
 - 2. Duct-Mounted Humidistats: Proportioning type with adjustable throttling range, 20 to 90 percent RH operating range, in galvanized-steel duct box.
 - 3. Cover Construction: Manufacturer's standard locking covers. Calibrated for +/- 5% RH accuracy.
 - a. Setpoint Adjustment: Concealed.
 - b. Setpoint Indication: Concealed.
 - c. Display: Concealed.
 - d. Color: _____.
 - e. Orientation: Vertical.
 - f. Output range: Linearly scaled from 3 psig to 15 psig (21 kPa to 103 kPa).
- C. Electric:
 - 1. Room or Duct-Mounted Humidistats: Electric insertion, 2-position type, with adjustable 2 percent RH throttling range, 20 to 90 percent RH operating range, and single- or double-pole contacts. Calibrated for +/- 5% RH accuracy.
 - 2. Cover Construction: Manufacturer's standard locking covers.
 - a. Setpoint Adjustment: Concealed.

- b. Setpoint Indication: Concealed.
- c. Display: Concealed.
- d. Color: _____.
- e. Orientation: Room sensor vertical.

2.15 ACTUATORS

- A. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
 - 1. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
 - 2. Motor characteristics such as NEMA designation, temperature rating, service factor, enclosure type, and efficiency are specified in Division 23 Section "Common Motor Requirements for HVAC Equipment." If different characteristics are required, insert additional subparagraphs below to suit Project.
 - 3. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
 - 4. Non-spring Return motors for valves larger than NPS 2-1/2 (DN 65): Size for running torque of 150 in x lbf (16.9 N x m) and breakaway torque of 300 in x lbf (33.9 N x m).
 - 5. Spring-Return motors for valves larger than NPS 2-1/2 (DN 65): Size for running and breakaway torque of 150 in x lbf (16.9 N x m).
 - 6. Non-spring Return motors for dampers larger than 25 sq. ft (2.3 sq. m): Size for running torque of 150 in x lbf (16.9 N x m) and breakaway torque of 300 in x lbf (33.9 N x m).
 - 7. Spring-Return motors for dampers larger than 25 sq. ft (2.3 sq. m): Size for running and breakaway torque of 150 in x lbf (16.9 N x m).
- B. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
 - 1. Manufacturers:
 - a. Belimo Aircontrols (USA).
 - 2. Valves: Size for torque required for valve close off at maximum pump differential pressure.
 - 3. Dampers: Size for running torque calculated as follows:
 - a. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft (87.0 kg-cm/sq. m) of damper cross-sectional area.
 - b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft (62.0 kg-cm/sq. m) of damper cross-sectional area.
 - c. Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft (49.7 kg-cm/sq. m) of damper cross-sectional area.
 - d. Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft (37.3 kg-cm/sq. m) of damper cross-sectional area.
 - e. Dampers with 2 to 3 inches wg (498 to 747 Pa) of Pressure Drop or Face Velocities of 1000 to 2500 fpm (5 to 12.7 m/s): Increase running torque by 1.5.
 - f. Dampers with 3 to 4 inches wg (747 to 996 Pa) of Pressure Drop or Face Velocities of 2500 to 3000 fpm (12.7 to 15.2 m/s): Increase running torque by 2.0.
 - 4. Coupling: V-bolt and V-shaped, toothed cradle.
 - 5. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
 - 6. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual, gear release on non-spring-return actuators.
 - 7. Manual Operation: Provided for all valve actuators.
 - 8. Power Requirements (Two-Position Spring Return): 24-V ac.
 - 9. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.

10. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
11. Temperature Rating: Minus 22 to 122 degrees F (Minus 30 to 50 degrees C).
12. Temperature Rating (Smoke Dampers): Minus 22 to 250 degrees F (Minus 30 to 121 degrees C).
13. Run Time: 12 seconds open, 5 seconds closed.

2.16 CONTROL VALVES

- A. Manufacturers:
 1. Erie Controls.
 2. Magnatrol Valve Corporation.
 3. Neles-Jamesbury.
 4. TAC Inc. (Schneider Electric).
- B. Control Valves - General:
 1. Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.
- C. Control Valve Piping –General:
 1. Brass- and bronze-body valves shall be piped with copper/brass/bronze pipe using copper/brass/bronze piping fittings. When piping connects to ferrous piping connections, dielectrics must be used.
 2. Steel- and iron-body control valves shall be piped with ferrous piping using ferrous pipe fittings. When piping connects to non-ferrous piping connections, dielectrics must be used.
- D. Standard valves are also available for Class 250, 250 psig (1724 kPa) and up to 350 degrees F (177 degrees C) operating conditions. Coordinate with mechanical system engineer.
- E. Hydronic Globe Control Valves shall have the following characteristics:
 1. NPS 2 (DN 50) and Smaller: Class 125 bronze body, bronze trim, rising stem, renewable composition disc, screwed ends, with back-seating capacity, and repackable under pressure.
 2. NPS 2-1/2 (DN 65) and Larger: Class 125 iron body, bronze trim, rising stem, plug-type disc, flanged ends, and renewable seat and disc.
 3. Internal Construction: Replaceable plugs and stainless steel or brass seats.
 - a. Single-Seated Valves: Cage trim provides seating and guiding surfaces for plug on top and bottom.
 - b. Double-Seated Valves: Balanced plug; cage trim provides seating and guiding surfaces for plugs on top and bottom.
 4. Sizing: 3 psig (21 kPa) maximum pressure drop at design flow rate or the following:
 - a. Two-Position: Line size or one size smaller.
 - b. Two-Way Modulating: Either the value specified above or twice the load pressure drop, whichever is more.
 - c. Three-Way Modulating: Twice the load pressure drop, but not more than value specified above.
 5. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.
 6. Close-Off (Differential) Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 150 percent of total system (pump) head for two-way valves and 100 percent of pressure differential across valve or 100 percent of total system (pump) head.
- F. Butterfly Control Valves shall have the following characteristics:
 1. Manufacturers:
 - a. Centerline (Crane).

- b. DeZurik.
 - c. Keystone.
 - 2. Rating: 150-psig (1034-kPa) maximum pressure differential, ASTM A126 cast-iron or ASTM A536 ductile-iron body and bonnet, extended neck, stainless-steel stem, field-replaceable EPDM or Buna N sleeve and stem seals.
 - 3. Butterfly valves are acceptable for piping or equipment isolation use. For modulating service, do not allow the valve to go over 60% open under control to the load.
 - 4. Body Style: Wafer
 - 5. Disc Type: Nickel-plated ductile iron
 - 6. Sizing: 3-psig (21-kPa) maximum pressure drop at design flow rate or the following:
 - a. Two-Position (isolation): 1-psi (7kPa) or less at design flow rate.
 - b. Two-Way Modulating: Either the value specified above or twice the load water pressure drop, whichever is more.
 - c. Three-Way Modulating: Twice the load water pressure drop, but not more than value specified above.
- G. Terminal Unit Control Valves shall have the following characteristics:
- 1. Rating: NPS 2 (DN 50) NPS 2 (DN 50) and smaller, bronze body, bronze trim, rising stem, two or three ports as indicated, renewable composition disc, sweat and threaded ends, with back-seating capacity, and repackable under pressure.
 - 2. Class 125 for service at 125-psig (860-kPa) and 250-F (121-C) operating conditions.
 - 3. Sizing: 3-psig (21-kPa) maximum pressure drop at design flow rate for hydronic valves and able to close against pump shutoff head.
 - 4. Flow Characteristics:
 - a. Hydronic Valves: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.
 - b. Steam Valves: Two-way valves shall have linear characteristics.
- H. Self-Contained Control Valves shall have the following characteristics:
- 1. Type: Bronze body, bronze trim, two or three ports as indicated, replaceable plugs and seats, and available in union and threaded ends.
 - 2. Rating: Class 125 for service at 125-psig (860-kPa) and 250-F (121-C) operating conditions.
 - 3. Thermostatic Operator: Wax-filled integral sensor with integral adjustable dial.
 - 4. Coordinate the following two sections with above requirements and Owner preference/acceptance.
- I. Pressure-Independent Characterized Control Valves (PICCV) shall have the following characteristics:
- 1. Manufacturers:
 - a. Belimo.
 - 2. NPS 1-1/4 (DN 32) and Smaller: Pressure rated at 400-psig (2758-kPa) body; 200-psig (1379-kPa) close-off pressure.
 - 3. Internal Construction: Internal construction: chrome plated brass ball and stem (stainless steel stem also acceptable), characterizing disc shall be brass or Tefzel and replaceable, diaphragm for small valves shall be Nomex or silicone, for larger valves polyester-reinforced silicone. End fittings shall be threaded (female NPT).
 - 4. Service: Chilled or heating hot water and glycol (up to 60% solution).
 - 5. Rating: Class 125 for service at 125-psig (860-kPa) and 250-F (121-C) operating conditions.
 - 6. Sizing: 3-psig (21-kPa) maximum pressure drop at design flow rate, to close against pump shutoff head.
 - 7. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.
 - 8. Provide spring-return actuators where noted on drawings or in schedules.

- J. Characterized Ball Valves shall have the following characteristics:
1. Manufacturers:
 - a. Honeywell International.
 - b. Johnson Controls.
 - c. Siemens Building Technologies.
 2. Service: Chilled water or heating hot water and glycol solutions (up to 60%). Full port ball valves shall be used only for pipe isolation service. Modulating service valves shall be characterized port valves.
 3. Internal construction: chrome or stainless steel-plated brass ball with stainless steel stem and trim, characterizing disc shall be plastic and replaceable.
 4. Rating: Class 125 for service at 125-psig (860-kPa) and 250-F (121-C) operating conditions.
 5. Sizing: 3-psig (21-kPa) maximum pressure drop at design flow rate; close off pressure no less than 130 psig (896-kPa)
 6. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.
 7. Provide spring-return actuators where noted on drawings or in schedules.

2.17 DAMPERS

- A. Manufacturers:
1. American Warming and Ventilating.
 2. Mestek.
 3. TAMCO.
 4. United Enertech Corp.
- B. Dampers: AMCA-rated, parallel blade per the design requirements; 0.108-inch (2.7-mm) minimum thickness, galvanized-steel or 0.125-inch (3.2-mm) minimum thick, extruded-aluminum frames with holes for duct mounting; damper blades shall not be less than 0.064-inch (1.6-mm) thick galvanized steel with maximum blade width of 8-inch (200-mm) and length of 48-inches (1220-mm)
1. Secure blades to 1/2-inch (13-mm) diameter, zinc-plated axles using zinc-plated hardware, with oil-impregnated, sintered bronze blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.
 2. Operating Temperature Range: From minus 40- to 200-F (- 40- to 93-C)
 3. Edge Seals, Standard Pressure Applications: Closed-cell neoprene or silicone.
 4. Edge Seals, Low-Leakage Applications: Use inflatable blade edging or replaceable rubber blade seals.
 5. Jamb Seals: spring-loaded, stainless steel, only.
 6. Leakage ratings or dampers shall be less than 0 cfm per sq. ft. (4.6 L/s per sq. m) of damper area, at differential pressure of 4-inches wg (1000-Pa) when damper is held by torque of 50 in. x lbf (5.6 N x m) when tested according to AMCA 500D.

2.18 AIR SUPPLY

- A. Pneumatic Controls Air Compressors
1. Manufacturers:
 - a. Quincy Compressor.
 - b. Gardner Denver (Champion).
 2. All compressors shall be designed and rated as "oil-less" for use in HVAC pneumatic control systems."
 3. Simplex Air Compressor: Tank-mounted compressor with capacity to supply compressed air to temperature control system, with starter, controls, and disconnect.
 - a. Pressure control with adjustable electric contacts, set to start and stop compressor at minimum and maximum pressures.

- b. Electrical motor starters and disconnect to operate compressor.
 - 4. Duplex Air Compressor: Capacity to supply compressed air to temperature control system.
 - a. Pressure control with adjustable electric contacts, set to start and stop both compressors at minimum and maximum pressures.
 - b. Electrical alternator panel set with motor starters and disconnect to operate compressors alternately or on time schedule.
 - 5. Compressor Type: Reciprocating
 - 6. Tank: ASME-certified, tested, and labeled, storage tank with drain test cock, automatic moisture removal trap, tank relief valve, and rubber/cork vibration isolation mounting pads.
 - 7. Size compressor and tank to operate compressor no more than 15 minutes during a 60-minute period.
 - 8. Pressure Relief Valves: ASME rated and labeled.
 - a. Tank High Pressure: Size for installed capacity
 - b. System Low Pressure: Size for installed capacity of pressure regulators and set at 20 percent above low pressure
 - 9. Compressor Accessories:
 - a. Low-resistance air-intake filter rated for 97 percent efficiency at rated airflow
 - b. Flywheel and belt guards
 - c. One spare belt for each compressor
- B. Control and Instrumentation Tubing:
 - 1. Metallic
 - a. Copper tubing complying with ASTM B88 - Type K, (ASTM B88M - Type A) or ASTM B280 , Type ACR.
 - b. Fittings: Cast-bronze or forged-brass solder fittings complying with ASME B16.18; or wrought-copper solder fittings complying with {RS#367}, except forged-brass compression-type fittings at connections to equipment.
 - c. Joining Method: Soldered or brazed.
 - 2. Polyethylene: ASTM D2737 Type FR plenum-rated polyethylene, flame-retardant, non-metallic tubing rated for 30-psig (207-kPa) and ambient temperature range of 10- to 150-F (-12- to 66-C) with flame-retardant harness for multiple tubing.
 - a. Fittings: Compression-type or push-on, barbed-brass fittings complying with ASME B16.18
- C. Refrigerated Air Dryer:
 - 1. Manufacturers:
 - a. Hankison Corp.
 - b. Ingersoll Rand.
 - 2. Self-contained, refrigerated air dryer complete with heat exchangers, moisture separator, internal wiring and piping, and with manual bypass valve.
 - 3. Heat Exchangers: Air-to-refrigerant coils with centrifugal-type moisture separator and automatic trap assembly.
 - 4. Refrigeration Unit: Hermetically sealed, operating to maintain dew point of 13-F (- 11-C) at ,20-psig (138-kPa) housed in steel cabinet with access door and panel.
 - 5. Accessories: Air inlet temperature gage, air inlet pressure gage, on-off switch, high-temperature light, power-on light, refrigerant gage on back, air outlet temperature gage, air outlet pressure gage, and with contacts for remote indication of power status and high-temperature alarm.
- D. Desiccant Dryer: Maintains dew point in pneumatic air piping between compressor and tank at least 15-F (- 9-C) below inlet-air dew point at design conditions.

- E. Pressure Gages: Black letters on white background 2-1/2-inches (64-mm) in diameter, flush or surface mounting, with front calibration screw to match sensor, and having a graduated scale in psig (kPa).
- F. Instrument Pressure Gages: Black letters on white background, 1-1/2-inches (38 mm) in diameter, stem mounted, with suitable dial range, and having a graduated scale in psig (kPa).
- G. Diaphragm Control and Instrument Valves: 1/4-inch (6 mm) forged-brass body with reinforced polytetrafluoroethylene diaphragm, stainless-steel spring, and color-coded phenolic handle.
- H. Gage Cocks: Tee or level handle, bronze, rated for 125-psig (862-kPa)
- I. Pressure Regulators: Zinc or aluminum castings with elastomeric diaphragm, balanced construction to automatically prevent pressure buildup, and producing flat, reduced-pressure curve.
- J. Particle Filters: Zinc or aluminum castings with 97 percent filtration efficiency at rated airflow, quick-disconnect service devices, and aluminum or plastic bowl with metal guard and manual drain cock.
- K. Combination Filter/Regulators: Zinc or aluminum castings with elastomeric diaphragm, balanced construction to automatically prevent pressure buildup, and producing flat reduced-pressure curve; with threaded pipe connections, quick-disconnect service devices, and aluminum or plastic bowl with metal guard and manual drain cock.
- L. Airborne Oil Filter: Filtration efficiency of 99.9 percent for airborne lubricating oil particles of 0.025 micron or larger.
- M. Pressure-Reducing Valves: Two parallel pressure regulators.

2.19 CONTROL CABLE

- A. Electronic and fiber-optic cables for control wiring are specified in Division 27 Section "Communications Horizontal Cabling."

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that a commercial power supply is available to control units and operator workstation.
- B. Verify that emergency power supply is available to control units and operator workstation if required for project.
- C. Verify that the UPS is rated for the controller power needs and has been provided.
- D. Verify that pneumatic piping and duct-, pipe-, and equipment-mounted devices are installed properly before proceeding with wiring installation.

3.02 INSTALLATION

- A. General
 - 1. Install software and/or custom programming in DDC control units and operator workstation(s). Implement all features of programs to specified requirements and as appropriate to sequence of operation.
 - 2. Connect and configure equipment and software to achieve sequence of operation specified.
 - 3. Install DDC controller panels in locations noted on plans or coordinate with Architect. Coordinate with Electrical Contractor for power.
 - 4. Install DDC temperature control instruments and devices on all controlled equipment per control plans and provide supply air and control branch air piping as required for a complete installation.
 - 5. DDC control system wiring in conduit, J-hooks, or installed in bridle rings (when allowed) shall:

- a. Run conduit runs along building and steel sight-lines (not diagonal or where support is improper).
 - b. Support all conduit with independent hangers, not from ductwork/piping or from ductwork/piping hangers/trays/supports/Unistrut; and independent of other trade's work.
 - c. Anchor J-hooks to walls or suspend J-hooks using 1/4-inch minimum diameter threaded rod hangers. Do not support J-hooks from ceiling or equipment hangers. J-hooks shall not impede removal of accessible ceiling tiles.
6. Control wiring and pneumatic tubing in conduit or installed exposed (when allowed) shall:
 - a. Run conduit runs along building and steel sight lines (not diagonal or where support is not proper).
 - b. Support all conduit with independent hangars, not from ductwork/piping or from ductwork/piping hangars/trays/supports and independent of other trade's work.
 - c. Anchor J-hooks to walls or suspend J-hooks using 1/4-inch minimum diameter threaded rod hangers. Do not support J-hooks from ceiling or equipment hangers. J-hooks shall not impede removal of accessible ceiling tiles.
 - d. Pneumatic tubing in mechanical equipment rooms shall always be installed in conduit or installed as copper tubing.
 - e. Pneumatic tubing installed in plenum air spaces (exposed or concealed) and in duct/piping shafts shall be plenum-rated by Underwriters' Laboratories Inc.
7. Mount compressor and tank unit on elastomeric mounts. Vibration isolators are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment." Isolate air supply with wire-braid-reinforced rubber hose. Secure and anchor according to manufacturer's written instructions and seismic-control requirements.
 - a. Pipe manual and automatic drains to nearest floor drain.
 - b. Supply instrument air from compressor units through dryer, filter, pressure reducing valve, and pressure relief valve, with pressure gages at inlet and outlet connections, and shutoff and bypass valves at the air dryer and filter/PRV combination.
8. Install temperature control panels in locations noted on plans or coordinate with Architect. Coordinate with Electrical Contractor for power.
9. Install temperature control instruments and devices on all controlled equipment per control plans and provide supply air and control branch air piping as required for a complete installation.
10. Verify location of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Installation height of devices.
 - a. Install averaging elements in ducts and plenums in crossing or zigzag pattern.
11. Install guards on thermostats in the following locations:
 - a. Building Entrances
 - b. Public areas and restrooms
 - c. Where indicated on drawings
12. Furnish automatic dampers according to Division 23 Section "Air Duct Accessories" to installing contractor for installation.
13. Install damper motors on outside of ductwork in warm areas, not in locations exposed to outdoor temperatures.
14. Install labels and nameplates to identify control components according to Division 23 Section "Identification for HVAC Piping and Equipment."
15. Furnish hydronic instrument wells, valves, and other accessories according to Division 23 Section "Hydronic Piping" to installing contractor for installation.
16. Furnish steam and condensate instrument wells, valves, and other accessories according to Division 23 Section "Steam and Condensate Heating Piping" to installing contractor for installation.
17. Install hydronic, gas, compressed air, and/or steam flow meters and accessories according to this specification and per locations shown on the plans.

18. Install refrigerant instrument wells, valves, and other accessories according to Division 23 Section "Refrigerant Piping."
19. Install electronic and fiber-optic cables according to Division 27 Section "Communications Horizontal Cabling."
- B. Electrical Wiring and Connection
 1. Install raceways, boxes, and cabinets according to Division 26 Section "Raceway and Boxes for Electrical Systems."
 2. Install building wire and cable according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
 3. Route conduit and plenum cables along building and steel lines (not diagonal) and do not hang conduit or bridle rings from ductwork and piping or their support means
 4. Install signal and communication cable according to Division 27 Section "Communications Horizontal Cabling."
 - a. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
 - b. Install exposed cable in raceway.
 - c. Install concealed cable in raceway.
 - d. Bundle and harness multi-conductor instrument cable in place of single cables where several cables follow a common path.
 - e. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
 - f. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
 - g. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.
 5. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.
 6. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

3.03 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:
 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
 2. Test and adjust controls and safeties.
 3. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 4. Pressure test control air piping at 30-psig (207-kPa) or 1.5 times the operating pressure for 24 hours, with maximum 5-psig (35-kPa) loss.
 5. Pressure test high-pressure control air piping at 150-psig (1034-kPa) and low-pressure control air piping at 30-psig (207-kPa) for 2 hours, with maximum 1-psig (7-kPa) loss.
 6. Test calibration of pneumatic controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
 7. Test each point through its full operating range to verify that safety and operating control setpoints are as required.
 8. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
 9. Test each system for compliance with sequence of operation.
 10. Test software and hardware interlocks.

C. DDC Verification:

1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
2. Check instruments for proper location and accessibility.
3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
4. Check that insertion instruments are located in the correct section of piping.
5. Check instrument piping for proper fittings, slope, material, and support.
6. Check instrument tubing for proper fittings, material, and support.
7. Check installation of air supply for each instrument.
8. Check water flow instruments. Inspect tag number and line and bore size, verify that upstream/downstream dimensions are per manufacturer's requirements, and that instruments are installed correctly.
9. Check airflow instruments. Inspect tag number and ductwork size, verify that upstream/downstream dimensions are per manufacturer's requirements, and that instruments are installed correctly.
10. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
11. Check temperature instruments, material, and length of sensing elements.
12. Check control dampers/valves. Verify that proper blade alignment, either parallel or opposed, has been provided. Verify that valves are installed in the correct direction.
13. Delete subparagraph below is all electric DDC controls.
14. Check air-operated dampers/valves. Verify that pressure gages are provided and that proper blade alignment, either parallel or opposed, has been provided. Verify that valves are installed in the correct direction. Verify that pilot positioners, end switches, and/or feedback devices if provided, are installed and calibrated properly.
15. Check electric-operated dampers/valves and hydraulic-operated valves. Verify that proper blade alignment, either parallel or opposed, has been provided. Verify that valves are installed in the correct direction. Verify end switches and/or feedback devices are installed properly.
16. Check DDC system as follows:
 - a. Verify that DDC controller power supply is from emergency power supply, if applicable.
 - b. Verify that wires at control panels are tagged with their service designation and approved tagging system.
 - c. Verify that spare I/O capacity has been provided.
 - d. Verify that DDC controllers are protected from power supply surges.

D. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

3.04 ADJUSTING

A. Calibrating and Adjusting:

1. Calibrate installed devices and instruments, whether electric or pneumatic.
2. Make three-point calibration test for both linearity and accuracy for each analog instrument.
3. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
4. Control System Inputs and Outputs:
 - a. Check analog inputs at 0, 50, and 100 percent of span.
 - b. Check analog outputs using milli-ampere meter at 0, 50, and 100 percent output.
 - c. Check digital inputs using jumper wire.
 - d. Check digital outputs using ohmmeter to test for contact making or breaking.

- e. Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.
- 5. Flow:
 - a. Set differential pressure flow transmitters for 0 and 100 percent values with 3-point calibration accomplished at 50, 90, and 100 percent of span.
 - b. Manually operate flow switches to verify that they make or break contact.
- 6. Pressure:
 - a. Calibrate pressure transmitters at 0, 50, and 100 percent of span.
 - b. Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.
- 7. Temperature:
 - a. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
 - b. Calibrate temperature switches to make or break contacts.
- 8. Stroke and adjust control valves and dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.
- 9. Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.
- 10. Provide diagnostic and test instruments for calibration and adjustment of system.
- 11. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.
- B. Adjust initial temperature, CO, CO₂, static pressure, humidity, etc., set points.
- C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other than normal occupancy hours for this purpose.

3.05 DEMONSTRATION AND TRAINING

- A. Engage a factory-authorized service representative of the manufacturer (or manufacturers authorized and trained installation representative) to demonstrate the system's operational status in all modes of control. This shall be arranged for the following:
- B. Modify this section to include unique arrangements and Owner's needs. This may vary significantly.
 - 1. Every control drawing Mxxx: Demonstrate system in all modes of operation per Sequence of Operation stated.
 - 2. Where there are multiple devices (VAV box, unit heater, cabinet unit heater, fan coil unit, etc.) installed identically, perform demonstration on 25% of the installed quantity, in all modes of operation per Sequence of Operation stated.
- C. Refer to Division 01 Section "Demonstration and Training."

3.06 GRAPHIC DISPLAY GENERATION

- A. Provide the following graphic displays as a minimum at the operator workstations, arranged in logical penetration paths:
 - 1. Overall campus layout which shows all of the buildings on the Owner's campus.
 - 2. Individual building layout or isometric for each building connected to the system.
 - 3. Floor plans for each floor within each building, with display of present values of space conditions sensed by connected space sensors, display of the name of the air handler associated with each space sensor, display of the room number in which the sensor is located and color coding to indicate whether the sensed space condition is within the acceptable range, is too high, or is too low. TC Contractor shall confirm Owner desired room names prior to graphics generation which may differ from the room names indicated on construction documents.

4. Schematic diagram for each HVAC system. Each system schematic display shall include at least the following:
 - a. Schematic arrangement of ductwork, fans, dampers, coils, valves, piping, pumps, equipment etc.
 - b. System name.
 - c. Area served.
 - d. Present value or status of all inputs, along with present setpoint.
 - e. Present percent open for each damper, valve, etc. based on commanded position.
 - f. Reset schedule parameters for all points, where applicable.
 - g. Present occupancy mode.
 - h. Present economizer mode, where applicable.
 - i. Present outside air temperature.
 - j. Associated space conditions and setpoints, where applicable.
 - k. Status of application programs (e.g., warm-up, night cycle, duty cycle, etc.).
 - l. Color coding to indicate normal and abnormal values, alarms, etc.
 5. Manual override capability for each on/off or open/closed controlled digital output (for fans, pumps, 2-position dampers and valves, etc.) and each modulating analog output (for dampers, valves, VFD speed modulation type points, etc) shall be provided. Graphic display of output point auto or manual override status shall be provided.
 6. Sequence of operation in written (text) format for each HVAC system.
 7. Overall BAS system schematic.
 8. System management graphic for each network device and/or DDC panel.
 9. Provide a separate page for critical alarm summary.
- B. Contractor to provide graphics that are fully operational prior to commissioning.

3.07 SYSTEMS INTEGRATION

- A. The following items have been provided and are prepared for Demonstration and Owner Training:
1. New DDC Controllers are interfaced to the existing EMS network.
 2. New DDC Controllers are fully and readily accessible from existing graphical user workstations.
 - a. Graphics "links" are provided from top most level graphic to sub-graphic (if existing) and then to the newly installed systems.
 - b. New systems are readily identifiable with links to the equipment controller graphic or another sub-graphic.
 - c. Back buttons ("links") take users back one level and provide a link out to the top-most graphic.
 3. All DDC/EMS communication wiring (cable) is coordinated and provided, and fully tested with the Owner's IT staff.
 4. EMS software upgrades or updates and networking software upgrades or updates have been provided, when required.
 5. Networking (building level) controllers requiring upgrades or updates have been provided, when required.

3.08 OWNER TRAINING

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel on how to operate, maintain, and adjust HVAC instrumentation and controls.
1. Training shall be provided for a period of 40 hours in 4-hour increments; to be scheduled with the Owner's representative at least 2-weeks in advance.
 2. Provide all training materials needed for a complete training session including but not limited to Operation and Maintenance Manuals, product catalogs, and "record drawings" of the controls installation.

3. Training shall be a combination of classroom (printed material and electronic presentations) and mechanical room (hands-on) instruction.

B. Refer to Division 01 Section "Demonstration and Training."

3.09 ACCEPTANCE PROCEDURE

- A. SUBMITTALS data relevant to point index, functions limits, sequences, interlocks, power fail/restarts, logs, software routines and associated parameters, and other pertinent information for the operating system and database shall be forwarded from the control system contractor to the Owner.
- B. Approved database will be entered into the central computer, debugged, and down line loaded to Controllers. Prior to on-line operation, a complete demonstration and readout of the computer command shall be performed in the presence of the Owner. In addition, a printout of the database generated for all points, shall be reviewed with the Owner by the control system contractor. Modification to the database shall be made by the control system contractor as directed by the Owner.
- C. All points shall be verified prior to "punch-out" for correct and accurate correspondence between the CRT data display and actual field location and equipment operation.
- D. Upon successful completion of system generation the Owner shall be requested in writing to inspect and approve the satisfactory operation of the control system, sub-systems, and accessories.

END OF SECTION

**SECTION 23 09 23
DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. DDC Networks
- B. Common DDC Hardware Requirements
- C. Building Controllers (B-BC)
- D. Advanced Application Controllers (B-AAC)
- E. Application Specific Controllers (B-ASC)
- F. DDC Software

1.02 GENERAL REFERENCES

- A. Drawings and general provisions of the Contract, including the General Conditions and Supplementary Conditions apply to this section.
- B. Division 20, including all Common Mechanical Requirements in Section 20 00 00, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.

1.03 RELATED REQUIREMENTS

- A. HVAC Control Sections:
 - 1. Section 23 09 00 – Common Work Results for HVAC Control
 - a. Requirements common to all HVAC Control Sections
 - 2. Section 23 09 13 – Instrumentation and Control Devices for HVAC
 - a. Input devices, output devices, control valves, control dampers
 - 3. Section 23 09 63 – Integrated Automation
 - a. BAS computer hardware, BAS software
 - 4. Section 23 09 93 – Sequence of Operations for HVAC Controls
 - a. Sequence of Operations, Points Matrices

1.04 SUBMITTALS

- A. Action Submittals
 - 1. Refer to 23 09 00 Submittals for requirements applicable to This Section, in addition to the requirements of This Article
 - 2. Product Data:
 - a. Schedules:
 - 1) Control Point Schedules (each DDC controller): Include all used and unused / spare points, one row for each point, one column for each of the following attributes:
 - (a) Point ID Number
 - (b) Point Name
 - (c) Point Description
 - (d) Type
 - (e) Address
 - (f) Connected Device Identification.
 - 2) Terminal Unit Controller Schedule: One row for each terminal unit controller, one column for each of the following attributes:
 - (a) Line Number
 - (b) Room Number (location of room sensor / room served)
 - (c) Address
 - (d) Controller Tag / Name

- (e) Terminal Unit Tag
- (f) Terminal Unit Location
- (g) Service (e.g. CV, VAV w/ RH, VAV Tracking Pair, etc...)
- (h) System, (e.g. AHU-xx, REF-yy)
- (i) Floor Plan Drawing Reference
- (j) TUC Model (i.e. part no., application no., etc...)
- (k) Box Size (nominal inch units)
- (l) Inlet Size (actual inch units)
- (m) Damper Rotation Angle
- (n) Air Flow Sensor Flow Coefficient (nominal for submittal / actual for as-built)
- (o) Actuator set-up (e.g. 0 signal = closed, etc...)
- (p) Maximum Primary CFM
- (q) Minimum Primary CFM
- (r) Maximum Secondary Cooling CFM (FP-VAV only)
- (s) Maximum Secondary Heating CFM (FP-VAV only)
- (t) Minimum Secondary Occupied CFM (FP-VAV only)
- (u) Associated Terminal Units (e.g. RHC-x, RP-y, RVAV-xx, etc...)

1.05 EXTRA MATERIALS

- A. Spare Parts:
 - 1. Deliver to Owner extra materials for products installed.
 - 2. Package products with protective covering and identify with descriptive labels.
 - 3. Provide the following Spare Parts. Percentages shall be applied separately to each unique type installed in this project. Provide minimum of 1 of each listed product in each unique type or configuration, unless noted otherwise.
- B. Microprocessor-based direct-digital controller hardware and software, for the direct control and monitoring of HVAC equipment and systems

1.06 TOOLS

- A. Deliver to Owner the following specialty tools required for ordinary operation and maintenance of the products installed:
 - 1. DDC Software:
 - a. One licensed copy per BAS laptop, of every DDC software tool employed by technicians during the installation, programming, and start-up of the project.
 - b. One licensed copy per BAS laptop, of every DDC software tool required for operation and maintenance of the projects installed.

PART 2 PRODUCTS

2.01 DDC NETWORKS

- A. General Requirements
 - 1. The direct digital control (DDC) defined in This Section shall utilize the BACnet protocol as defined by ANSI/ASHRAE 135-2012 for all communication between controllers, servers, and workstations.
 - 2. The DDC defined in This Section shall utilize products tested according to ASHRAE 135.1-2013 and listed as compliant by the BACnet Testing Laboratories of BACnet International, unless tested and listed products are not available from any manufacturer for a particular application.
- B. First Tier Network:
 - 1. The first tier network shall be the Building Systems TCP/IP Ethernet network:
 - a. Structured cabling for the Owner's Network is defined by Division 27
 - b. Active equipment for the Owner's Network, such as switches, routers, and firewalls, will be provided by Owner.

- c. The network will be managed by Owner, and Owner will provision all required or optional network services, such as VLANs, Domains, Active Directory, SMTP servers, etc.
 2. There shall only be one single first tier network serving the entire building.
 3. The first tier network shall not be utilized for any smoke management functionality, nor form part of a smoke management system. This network will not be a UUKL864 network.
 4. The first tier network shall support the BAS software platform, including an application server, multiple operator workstations, and printers. Refer to Section 23 09 63 Integrated Automation for additional BAS requirements.
 5. The first tier network shall also support DDC controllers such as Building Controllers (B-BC) and Advanced Application Controllers (B-AAC).
 6. The first tier network shall provide communications transport among connected DDC controllers, and between connected DDC controllers and the BAS platform.
 7. The first tier network shall operate at 10/100/1000 Mbps. Devices connected to the first tier network shall support operation at 100 Mbps at minimum, preferably 100 Mbps.
 8. The first tier devices shall communicate via BACnet/IP, ASHRAE 135 Annex J unless noted otherwise. Fox protocol shall also be permitted as an additional communications option, but in all cases BACnet/IP shall be provided with each device.
 9. The first tier shall also support alternate communication protocols as required for interface to third-party devices, for support of Enterprise application connectivity, and for browser user interface.
 10. Advanced Application Controllers (B-AAC) are permitted to reside on the first tier.
 11. Components of the BAS under 23 09 63 shall reside on the first tier.
- C. Second Tier Network:
1. Second tier networks shall provide either "Peer-to-Peer" serial communications to support DDC controllers such as Advanced Application Controllers (B-AAC) and Application Specific Controllers (B-ASC), and their interface to Building Controllers (B-BC).
 2. There shall be multiple second tier networks, quantity as required to support all connected devices.
 3. The second tier networks are provided under This Section.
 4. The second tier devices shall communicate via BACnet MS/TP, ASHRAE 135, on EIA-485 twisted shield cable, unless noted otherwise.
 5. The second tier networks shall operate at 78.6 kbps minimum. Devices connected to the second tier networks shall support 78.6 kbps operation.
 6. Each second tier network shall be connected to a Building Controller (B-BC).
 7. Data objects on an individual second tier network shall be capable of being shared over the first tier network to other second tier networks.
 8. Application Specific Controllers (B-ASC) shall reside on the second tier only.
 9. Advanced Application Controllers (B-AAC) are permitted to reside on the second tier.
- D. Third Tier Network:
1. Third tier networks are sensor-level networks, providing manufacturer-specific support for connected sensor devices only, or are controller-specific networks, providing manufacturer-specific support between host controller and expansion I/O modules only.
 2. Third tier networks are not required under This Section, but are permitted.
 3. Each third tier network shall connect to only one controller maximum. Third tier networks shall not be used for communications between controllers.
- E. Gateways and Routers:
1. Building Controllers (B-BC) and BACnet Routers shall be the only devices permitted to interface between first tier and second tier networks.

2.02 COMMON DDC HARDWARE REQUIREMENTS

- A. All DDC Controllers shall be either UL 916 or CSA listed and shall be FCC class B compliant.

B. Spare Capacity

1. Provide each Building Controller (B-BC), Advanced Application Controller (B-AAC), and Application Specific Controller (B-ASC) with sufficient internal memory for the specified control sequences, alarming and history trending and have at least 50% of the memory available for future use.
2. Each B-BC and B-AAC shall have a minimum of ten percent on-board spare I/O point capacity for future point expansion. B-ASC do not require spare I/O capacity.
3. The type of spares shall be in the same proportion as the implemented I/O functions of the controller, but in no case shall there be less than one spare I/O point for each implemented I/O type.
4. Provide all processors, power supplies, communication controllers, and I/O point modules so that the implementation of a point only requires the addition of the appropriate point field wiring and device.

C. Expansion Point Modules

1. Where the on-board point capacity of a B-BC or B-AAC cannot meet the specified application, provide point expansion point modules within the same local control panel.
2. Point expansion modules shall communicate directly with the controller's processor on a dedicated third tier communication bus. Use of a first or second tier network for controller to expansion module communication is not allowed.
3. Where point expansion modules are provided, adhere to Spare Capacity for points as specified. The future ability to add point expansion modules to a controller shall not be a substitution for on-board Spare Capacity – Spare Capacity shall be fully provided.
4. The installation of remote input/output point modules outside the enclosure for the system or programmable controller shall not be permitted.

2.03 BUILDING CONTROLLERS (B-BC)

A. General:

1. B-BC shall be tested and listed by the BACnet Testing Laboratories of BACnet International as compliant with the B-BC profile.
2. B-BC shall be capable of controlling major mechanical equipment and systems, when provided with on-board or local expansion I/O.
3. B-BC shall be capable of executing global supervisory control strategies among other DDC controllers on the connected first or second tier networks.
4. B-BC shall be capable of operating the connected equipment / system according to sequence of operation as stand-alone, without network connection, B-OWS availability, or other B-BC availability.
5. B-BC shall be fully programmable from an Operator Workstation, and the applications shall remain resident in non-volatile memory within the B-BC.

B. Communications Networks:

1. First Tier: B-BC shall reside on the first tier network.
2. Primary Second Tier: Each B-BC shall support a network of a minimum of 32 controllers on a second tier network, or as required by application.
3. Additional Second Tier: B-BC may provide multiple second tier network ports, and may provide network ports supporting alternate industry standard open protocols such as M-Bus, Modbus/RTU, LonWorks, DALI, and KNX/EIB when required for interface to systems and devices provided under other Sections.
4. Third Tier: B-BC may provide a manufacturer-specific third-tier sensor network for connection of sensors. Third tier network shall not be used for remote I/O.

C. Capabilities:

1. Processor: B-BC shall be microprocessor-based with a maximum program scan rate of 3 seconds. They shall be multi-tasking, multi-user, real-time digital control processors consisting of modular hardware with plug-in enclosed processors, communication

controllers and power supplies. Controller size and capability shall be sufficient to fully meet the requirements of this specification, the sequence of operation, and the control points matrix.

2. Memory: Each B-BC shall have sufficient memory to conform to the performance requirements, as specified below, to support its own operating system, databases, control programs and to provide continuous real-time polling and supervisory control for all connected second tier controllers.
3. Hardware Real Time Clock: The B-BC shall have an integrated hardware based real time clock, capable of synchronizing to a master system clock, and capable of passing clock synchronization to all connected second tier controllers.
4. Diagnostics: B-BC shall continuously perform self-diagnostics, communication diagnosis and diagnosis of all panel components. The B-BC shall provide both local and remote annunciation of any detected component failures, low battery conditions or repeated failure to establish communication.
5. EMF Isolation: Isolation shall be provided at all network terminations, as well as all field point terminations, to suppress induced voltage transients consistent with IEEE Standards 587-1980.
6. Power Failure: In the event of the loss of input power, there shall be sufficient reserve power to perform an orderly shut-down of the B-BC, to prevent the loss of database or operating system software. Non volatile memory shall be incorporated for all critical B-BC configuration data, and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 72 hours without input power.

D. Input / Output Point Functionality:

1. General
 - a. B-BC are not required to implement onboard input / output (I/O) points when used as a supervisory controller.
 - b. When B-BC are used to directly control equipment, the B-BC shall provide I/O in sufficient quantity that all field devices and sensors associated with that equipment or system connect to a single controller. It shall be prohibited to distribute control of a single system or equipment across multiple controllers, unless expressly noted otherwise.
 - c. I/O points shall be implemented locally only, either on-board the B-BC, or outboard as expansion modules within the same Local Control Panel. Remote I/O is prohibited.
2. Input Points:
 - a. Universal inputs shall have a minimum of 12 bit A/D resolution and shall monitor the following analog and binary signals:
 - 1) Thermistors and RTDs of standard curves.
 - 2) 4-20 mA Sensors.
 - 3) 0-10 VDC Sensors.
 - 4) Dry (Voltage-Free) Contact Closures.
 - 5) Pulse Counter and Accumulation with a maximum frequency of 40 Hz.
 - b. Inputs shall provide over-voltage and over-current (i.e. short) protection.
 - c. Inputs shall provide optional software filtering or signal conditioning to eliminate false signals resulting from input "bouncing".
 - d. Provide local LED for status indication of each binary input point.
3. Output Points:
 - a. Analog outputs shall have a minimum of 8 bit D/A resolution and shall provide the following control outputs:
 - 1) 4-20 mA - Sink or Source, capable of sourcing 75mA at 12VDC.
 - 2) 0-10 VDC.
 - 3) Floating type analog outputs are prohibited for valve and actuator applications unless noted otherwise.

- b. Binary outputs shall provide SPDT (Form-C) output contacts rated for 2 amps minimum at 24 VAC. Provide pilot relays when required to meet this requirement. Provide local LED for status indication of each binary output point. Inductive loads shall always be controlled by pilot relays.
- c. Outputs shall provide over-voltage and over-current (i.e. short) protection.
- 4. Manual Override Switches:
 - a. Provide the ability to manually override each controller's binary and analog output points.
 - 1) Manual override switches shall allow Hand, Off, and Auto control of the output using an accessible switch. Jumper type overrides are not acceptable.
 - 2) Analog outputs shall include rotary potentiometers with graduated scale to control the output value in Hand mode.
 - b. Manual override switches shall be independent of the controller's processor and function when the processor has failed or is off-line. Software override using onboard LCD or remote Operator Display are not permitted substitutes for HOA switches.
 - c. Each manual override switch shall be monitored by the controller such that an override not in the automatic position (e.g. hand and off) is specifically indicated.
 - d. B-BC shall collect override status of all output points and provide a summary report on the operator workstation of all override activity.

2.04 ADVANCED APPLICATION CONTROLLERS (B-AAC)

- A. General:
 - 1. B-AAC shall be tested and listed by the BACnet Testing Laboratories of BACnet International as compliant with the B-AAC profile.
 - 2. B-AAC shall be capable of controlling small to medium sized mechanical equipment and systems, when provided with on-board or local expansion I/O.
 - 3. When B-AAC does not have on-board or local expansion I/O capacity for an application, provide B-BC for that application.
 - 4. B-AAC shall be capable of operating the connected equipment / system according to sequence of operation as stand-alone, without network connection, B-OWS availability, or B-BC availability.
 - 5. B-AAC shall be fully programmable from an Operator Workstation, and the applications shall remain resident in non-volatile memory within the B-AAC.
- B. Communications Network:
 - 1. First / Second Tier: B-AAC may reside on the first tier or second tier network.
 - 2. No Routing: B-AAC may provide multiple physical media or protocol choices at start-up time, but B-AAC shall not support multiple simultaneous functional networks, nor any routing or gateway (protocol translation) functions. Where multiple networks, routing, or protocol translation is required, provide B-BC for that application.
 - 3. Third Tier: B-AAC may provide a manufacturer-specific third-tier sensor network for connection of sensors. Third tier network shall not be used for remote I/O.
- C. Capabilities:
 - 1. Processor: B-AAC shall be microprocessor-based with a maximum program scan rate of 3 seconds. They shall be multi-tasking, multi-user, real-time digital control processors consisting of modular hardware with plug-in enclosed processors, communication controllers and power supplies. Controller size and capability shall be sufficient to fully meet the requirements of this specification, the sequence of operation, and the control points matrix.
 - 2. Memory: Each B-AAC shall have sufficient memory to conform to the performance requirements, as specified below, to support its own operating system, databases, and control programs.

3. Hardware Real Time Clock: The B-AAC shall have an integrated hardware based real time clock, capable of synchronizing to a B-BC or B-OWS.
 4. Diagnostics: B-AAC shall continuously perform self-diagnostics, communication diagnosis and diagnosis of all panel components. The B-AAC shall provide both local and remote annunciation of any detected component failures, low battery conditions or repeated failure to establish communication.
 5. EMF Isolation: Isolation shall be provided at all network terminations, as well as all field point terminations to suppress induced voltage transients consistent with IEEE Standards 587-1980.
 6. Power Failure: In the event of the loss of input power, there shall be sufficient reserve power to perform an orderly shut-down of the B-AAC to prevent the loss of database or operating system software. Non volatile memory shall be incorporated for all critical controller configuration data, and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 72 hours without input power.
 - a. During a loss of power, the control sequences shall go to the normal system shut-down conditions, unless otherwise specified in a Sequence of Operation.
 - b. Upon restoration of power, after a minimum off time delay, the B-AAC shall automatically resume full operation without manual intervention through a normal soft-start sequence. Reference Sequence of Operation for additional requirements.
 - c. Should a B-AAC memory be lost for any reason, the system shall automatically reload the program transparently and without any intervention by building personnel.
 - d. Building personnel shall have the capability of manually reloading the B-AAC from the operator workstation across intermediary networks.
- D. Input / Output Point Functionality:
1. General
 - a. B-AAC shall provide I/O in sufficient quantity that all field devices and sensors associated with that equipment or system connect to a single controller. It shall be prohibited to distribute control of a single system or equipment across multiple controllers, unless expressly noted otherwise.
 - b. I/O points shall be implemented locally only, either on-board the B-AAC, or outboard as expansion modules within the same Local Control Panel. Remote I/O is prohibited.
 2. Input Points:
 - a. Universal inputs shall have a minimum of 12 bit A/D resolution and shall monitor the following analog and binary signals:
 - 1) Thermistors and RTDs of standard curves.
 - 2) 4-20 mA Sensors.
 - 3) 0-10 VDC Sensors.
 - 4) Dry (Voltage-Free) Contact Closures.
 - 5) Pulse Counter and Accumulation with a maximum frequency of 40 Hz.
 - b. Inputs shall provide over-voltage and over-current (i.e. short) protection.
 - c. Inputs shall provide optional software filtering or signal conditioning to eliminate false signals resulting from input "bouncing".
 - d. Provide local LED for status indication of each binary input point.
 3. Output Points:
 - a. Analog outputs shall have a minimum of 8 bit D/A resolution and shall provide the following control outputs:
 - 1) 4-20 mA - Sink or Source, capable of sourcing 75mA at 12VDC.
 - 2) 0-10 VDC.
 - 3) Floating type analog outputs are prohibited for valve and actuator applications unless noted otherwise.
 - b. Binary outputs shall provide SPDT (Form-C) output contacts rated for 2 amps minimum at 24 VAC. Provide pilot relays when required to meet this requirement.

Provide local LED for status indication of each binary output point. Inductive loads shall always be controlled by pilot relays.

- c. Outputs shall provide over-voltage and over-current (i.e. short) protection.
- 4. Manual Override Switches:
 - a. Provide the ability to manually override each controller's binary and analog output points.
 - 1) Manual override switches shall allow Hand, Off, and Auto control of the output using an accessible switch. Jumper type overrides are not acceptable.
 - 2) Analog outputs shall include rotary potentiometers with graduated scale to control the output value in Hand mode.
 - b. Manual override switches shall be independent of the controller's processor and function when the processor has failed or is off-line. Software override using onboard LCD or remote Operator Display are not permitted substitutes for HOA switches.
 - c. Each manual override switch shall be monitored by the controller such that an override not in the automatic position (e.g. hand and off) is specifically indicated.
 - d. B-AAC shall collect override status of all output points and provide a summary report on the operator workstation of all override activity.

2.05 APPLICATION SPECIFIC CONTROLLERS (B-ASC)

- A. General:
 - 1. B-ASC shall be tested and listed by the BACnet Testing Laboratories of BACnet International as compliant with the B-ASC profile.
 - 2. B-ASC shall be capable of controlling fixed-profile terminal unit and small-sized mechanical equipment / systems with on-board I/O, and may provide integral sensors and integral actuators.
 - 3. When B-ASC does not have on-board I/O capacity for an application, provide B-AAC or B-BC for that application.
 - 4. B-ASC shall be capable of operating the connected equipment / system according to sequence of operation as stand-alone, without network connection, B-OWS availability, B-AAC, or B-BC availability.
 - 5. B-ASC may be fully programmable from an Operator Workstation, or may provide a fixed configurable application. The application and configurations shall remain resident in non-volatile memory within the B-ASC. When B-ASC with a fixed configurable application cannot meet the design sequence of operations, provide a fully programmable B-ASC, a B-AAC, or a B-BC for that application.
- B. Communications Network:
 - 1. First / Second Tier: B-ASC shall reside on the second tier unless expressly noted otherwise. If first tier B-ASC are considered as an alternate or substitute, the additional cost of structured cabling systems and active network electronics (i.e. switches) shall be included in the pricing.
 - 2. Third Tier: B-ASC may provide a manufacturer-specific third-tier sensor network for connection of sensors. Third tier network shall not be used for remote I/O.
- C. Capabilities:
 - 1. Processor: B-ASC shall be microprocessor-based with a maximum program scan rate of 3 seconds. They shall be multi-tasking, multi-user, real-time digital control processors consisting of modular hardware with plug-in enclosed processors, communication controllers and power supplies. Controller size and capability shall be sufficient to fully meet the requirements of this specification, the sequence of operation, and the control points matrix.
 - 2. Memory: Each B-ASC shall have sufficient memory to conform to the performance requirements, as specified below, to support its own operating system, databases, and control programs.

3. Hardware Real Time Clock: The B-ASC shall have an integrated hardware based real time clock, capable of synchronizing to a B-BC, B-AAC, or B-OWS.
 4. Diagnostics: B-ASC shall continuously perform self-diagnostics, communication diagnosis and diagnosis of all panel components. The B-ASC shall provide both local and remote annunciation of any detected component failures, low battery conditions or repeated failure to establish communication.
 5. EMF Isolation: Isolation shall be provided at all network terminations, as well as all field point terminations to suppress induced voltage transients consistent with IEEE Standards 587-1980.
 6. Power Failure: In the event of the loss of input power, there shall be sufficient reserve power to perform an orderly shut-down of the B-ASC to prevent the loss of database or operating system software. Non volatile memory shall be incorporated for all critical controller configuration data, and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 72 hours without input power.
 7. Onboard Sensors and Actuators: B-ASC may contain onboard sensors or actuators, provided that each onboard device meets the applicable specifications for the device type.
- D. Input / Output Point Functionality:
1. General
 - a. B-ASC shall provide I/O in sufficient quantity that all field devices and sensors associated with that equipment or system connect to a single controller. It shall be prohibited to distribute control of a single system or equipment across multiple controllers, unless expressly noted otherwise.
 - b. I/O points shall be implemented locally only, either on-board the B-ASC, or outboard as expansion modules within the same Local Control Panel. Remote I/O is prohibited.
 2. Input Points:
 - a. Universal inputs shall have a minimum of 10 bit A/D resolution and shall monitor the following analog and binary signals:
 - 1) Thermistors and RTDs of standard curves.
 - 2) 4-20 mA Sensors.
 - 3) 0-10 VDC Sensors.
 - 4) Dry (Voltage-Free) Contact Closures.
 - 5) Pulse Counter and Accumulation with a maximum frequency of 40 Hz.
 - b. Inputs shall provide over-voltage and over-current (i.e. short) protection.
 - c. Inputs shall provide optional software filtering or signal conditioning to eliminate false signals resulting from input "bouncing".
 - d. Provide local LED for status indication of each binary input point.
 3. Output Points:
 - a. Analog outputs shall have a minimum of 8 bit D/A resolution and shall provide the following control outputs:
 - 1) 4-20 mA - Sink or Source, capable of sourcing 75mA at 12VDC.
 - 2) 0-10 VDC.
 - 3) Floating type analog outputs are prohibited for valve and actuator applications unless noted otherwise.
 - b. Binary outputs shall provide SPDT (Form-C) or SPST Triac output contacts rated for 2 amps minimum at 24 VAC. Provide pilot relays when required to meet this requirement. Provide local LED for status indication of each binary output point. Inductive loads shall always be controlled by pilot relays. Field controls which are subject to an open circuit condition shall always be controlled by pilot relays when driven by Triac output.
 - c. Outputs shall provide over-voltage and over-current (i.e. short) protection.

2.06 DDC SOFTWARE

A. General Requirements

1. The software control language(s) used in all digital controllers shall provide point identifications which are a minimum of 12 alpha/numeric characters in length.
2. All process set points, time delays and similar parameters identified as adjustable in the sequence of operations or on the control point matrix shall accessible for adjusting through the OWS without the need for editing or recompiling the program source code.
3. There shall be a maximum of two (2) programming application environments (also known as software tool, programming tool, or programming language) used by the BAS.
 - a. The fully programmable application environment used by B-BC and B-AAC.
 - b. The configuration application environment used by B-ASC.
 - c. Alternately, the B-BC may use one application environment, while the B-AAC and B-ASC share an environment, provided that all requirements below are met.
 - d. The application environments may be integral to the OWS software, or may be provided as separate software applications. Regardless, it shall be possible to operate all application environments as well as the OWS software on each OWS and portable OWS computer. It shall additionally be possible to connect with all DDC controllers across the first and second tier networks, for point interrogation, configuration adjustment, and application download from an OWS. Direct connection to a controller shall not be required.

B. Fully Programmable Application Environment:

1. General Requirements:
 - a. All necessary software, operating systems, and firmware to form a complete and operating direct digital controller as described in this specification shall be provided and shall reside solely within each individual controller.
 - b. Execution of the control program within each controller shall be completely independent of other computers or controllers for execution, except where specific software variables are required from the network, such as outside air temperature.
 - c. The fully programmable application environment shall be used to create, debug, compile, and download control programs into the individual controllers. It shall also be used to update controller firmware, when necessary.
2. Control Program Capabilities:
 - a. Controllers shall execute custom, job-specific control programs, to automatically perform calculations and special control routines in order to operate the connected equipment according to sequence of operation.
3. Application Environment:
 - a. Control programs shall be authored in a graphical object-based environment. While line code may be utilized to create scripts or sub-routines, line code shall not be the primary method of control program authoring.
 - b. The application environment shall at all times store the source code (i.e. human-readable version) of the control program, to be used for future editing. The source code shall remain on the local storage of an OWS, and will remain property of the project Owner. Program obfuscation, removal of source code from project site, or local storage of only the compiled binary files shall not be accepted.
 - c. Program source code shall allow for unlimited comments for documentation of software function and use by the programmer.
 - d. The application environment shall include online documentation and online tutorials to assist in developing programming skills.
 - e. The application environment must be simple and concise in use. It must provide a complete library of common logic and programming functions as building blocks for control program development.
 - f. The application environment must permit the creation of custom groups of functions which are commonly repeated throughout the project. These groups or templates shall be saved to a library for future reuse.

4. Schedules:
 - a. Controllers shall provide user definable schedules as follows:
 - 1) Weekly schedules with multiple Start/Stop times for each day of the week.
 - 2) Temporary weekly override schedules.
 - 3) Special override schedules for specific user selectable calendar dates.
 - 4) Holiday scheduling, including floating holidays.
 - b. Weekly schedules shall be provided for each piece of equipment with a specific time use schedule. Each schedule shall include start and stop times for each day of the week. Multiple weekly schedules may be grouped together to control a single piece of equipment or equipment group.
 - c. It shall be possible to define one or more master holiday schedules to allow the operator to define in one location the holidays for all associated schedules. Systems requiring the operator to change holiday definitions on a schedule by schedule basis shall not be accepted.
 - d. Standard weekly schedules shall be inactive on a holiday. The system shall allow the user to include in a schedule group a schedule which will only be active if today is a holiday.
 - e. Temporary weekly overrides schedules may be inserted into schedule groups for modified operating schedules. After overrides have been executed, the original schedule will automatically be restored.
 - f. Schedules shall be provided for each system, or sub-system in the facility. Each schedule shall include all commandable points residing within the system. Each point may have a unique schedule of operation relative to the system use schedule, allowing for sequential starting and control of equipment within the system.
 - g. Special days shall automatically reschedule equipment operation as previously defined on the weekly schedules on a specific calendar date.
5. Historical Data Collection: Historical data collection utilities shall be provided to automatically sample, store and display system data for points as specified.
 - a. Each controller shall store point history data for all analog and digital inputs and outputs as follows:
 - 1) Any point, physical or calculated may be designated for trending. Two methods of collection shall be provided:
 - (a) Pre-defined time interval.
 - (b) Upon a change of value.
 - (c) Sample intervals of 1 controller scan to 7 days shall be provided. Each system controller shall have a dedicated RAM-based buffer for trend data and shall store a minimum of 96 samples for each physical point and software variable, including an individual sample time/date stamp. Points may be assigned to multiple history trends with different collection parameters.
 - 2) Trend and change of value data shall be stored within the controller and uploaded to the workstation when retrieval is desired. Uploads shall occur based upon either a user-defined interval, manual command or when the trend buffers are full. All trend data shall be available for use in 3rd party personal computer applications such as Excel via a single command data export utility.
 - 3) Provide formatted trend report displays for each point. Include all trend data and associated parameters.
 - 4) Provide preformatted commands to view and print trend reports.
6. Alarms: Alarm management shall be provided to monitor and direct alarm information to operator devices. Each controller shall perform distributed, independent alarm analysis and filtering to minimize operator interruptions due to non-critical alarms, minimize network traffic and prevent alarms from being lost. At no time shall the controller ability to

report alarms be affected by either operator activity at a workstation, local I/O device or communications with other panels on the network.

- a. All alarm or point change reports shall include the point's English language description and the time and date of occurrence.
 - b. The user shall be able to define the specific system reaction for each point. Each alarm shall have user definable destination categories (e.g. PC, printer, system controller, pager, etc.) to provide full flexibility in defining the handling of system alarms. Each system controller shall automatically inhibit the reporting of selected alarms during system shut-down and start-up. Users shall have the ability to manually inhibit alarm reporting for each point. The contractor shall request from the Owner a configuration list for all alarms to be activated for the system and shall configure the initial alarms as requested. After configuring the initial alarms, the Contractor shall train the building operators on the use and configuration of the alarm system. After the training has been completed the building operators shall be responsible for alarm management and configuration.
 - c. Alarm reports and messages will be directed to a user-defined list of operator devices and/or workstations.
 - d. In addition to the point's descriptor and the time and date, each system controller shall store a library of at least 50 custom alarm messages. Each message may be assignable to any number of points in the controller. The alarm message shall be a minimum of 60 characters.
 - e. Operator-selected alarms shall initiate an e-mail message via the Internet to remote operator devices, such as digital PDAs, digital pagers and PCs.
 - f. Local Alarms
 - 1) The controller shall provide alarm monitoring for all analog input values that are outside of user definable ranges, for all binary alarm status points and for all binary output points that do not prove status based on a paired binary input status point. The user shall be able, from the operator workstation, to configure the alarm limit ranges, limit dead-bands and to enable/disable the alarm.
 - 2) The user shall be able to configure any controller alarm as a conditional alarm that will only occur when a selected binary point is ON or OFF. This shall be used to prevent nuisance alarms during non-operating and/or system startup modes.
 - 3) Temperature alarms shall be operator configured to alarm based on:
 - 4) An operator adjustable alarm dead band which shall generate a warning or alarm whenever the temperature is above the current active set point plus the alarm dead band or below the current active set point minus the alarm dead band.
 - 5) High and Low alarm limit set points with either return to normal values or dead bands.
7. Controllers shall automatically accumulate and store run-time hours for all digital input and output points.
 - a. The totalization routine shall have a sampling resolution of one minute or less.
 - b. The user shall have the ability to define a warning limit for run-time totalization for each point. Unique, user-specified messages shall be generated when the limit is reached.
 - c. Provide a formatted report display for each point showing all calculated data and associated parameters.
 8. Controller shall automatically accumulate and store the Average, Minimum and Maximum values for all Analog input and output points.
 - a. Provide a formatted report display for each point showing all calculated data and associated parameters.

9. Controllers shall automatically sample, calculate and store consumption totals on a daily, weekly and monthly basis for all analog and digital pulse type inputs monitoring flow, KW, KWH, etc.
 - a. Totalization shall provide calculation and storage of accumulations of up to 99,999 units (e.g. KWH, gallons, BTU, tons, etc.)
 - b. The totalization routine shall have a sampling resolution of one minute or less.
 - c. The user shall have the ability to define a warning limit. Unique, user-specified messages shall be generated when the limit is reached.
 - d. Provide a formatted report display for each point showing all calculated data and associated parameters.
- C. Application Specific Controller Programming Environment
 1. General:
 - a. B-ASC shall be specifically manufactured to control HVAC terminal devices and unitary equipment such as VAV Terminals, Heat Pump, Fan Coils, etc.
 - b. All software operating parameters shall be available to the B-BC and to all B-OWS.
 - c. Configuration of the B-ASC shall be performed from the B-OWS across the networks.
 - d. B-ASC shall provide temperature control accuracy from -1 deg F (-0.5 deg C) below heating set point to +1 deg F (+0.5 deg C) above cooling set point. Controller shall provide a dead-band to prevent short cycling between heating and cooling modes.
 - e. The operator workstation software shall make permanent parameter value changes without having to reload the controller program or configuration file. Permanent parameter value changes shall not interfere with normal temperature control operation.
 2. Programming Environment:
 - a. The B-ASC may use either the primary programming language or a 'wizard' question and answer tool that allows the operator to select a predefined operating sequence (for example: VAV with 2 stages of reheat) and use a forms type editor to "fill in the blanks" to set all required parameters to make the controller fully functional.
 - b. The user shall be able to select the operating personality for a B-ASC from a B-OWS.
 3. After Hours Override Request:
 - a. Each B-ASC identified on drawings and in sequences as having an after hours override request push button shall monitor the status of the button.
 - b. When in an unoccupied mode of operation, the controller shall activate an after hours override request for a user programmable time period, initially set for 2 hours, whenever the override push button is pressed. The override request shall be detected by the supervising B-BC which shall initiate after hours system operation per the system sequence of operation.
 - c. The B-ASC shall accumulate total after hour usage. A user command shall be provided to zero the after hours accumulated value.
 - d. The B-ASC shall record in a history log the start and end time and date of each after hours override request.
 - e. Provide a formatted report display for each controller showing all after hours accumulated data and associated parameters.
 4. Schedules:
 - a. B-ASC shall provide an internal scheduling system. The system shall be supported by the controller's hardware or software clock and shall operate in a stand-alone mode when isolated from network communications.
 - b. The system shall provide for a minimum of three different operating periods per day. These periods may be assigned to; Morning Warm-up, Morning Cool-down, Night Setback, Unoccupied or Occupied sequences.
 - c. Each operating period shall have individual start/stop times for each day of the week and shall have individual heating and cooling set points to be used as the active set points during that period.

- d. The supervising B-BC and B-OWS shall read and write schedules within the B-ASC.
- e. The operator shall be able to group controllers into a common schedule group. Modifications to shared schedules for the group shall be automatically downloaded to each terminal unit controller.
- 5. Historical Data Collection:
 - a. For B-ASC which do not provide history data collection internally, all points shall be trended within the supervising B-BC.
 - 1) Trends of B-ASC points within a B-BC shall conform to the general specifications for trends within system or network controllers.
 - 2) Each analog input shall collect 96 samples within a first-in first-out rotating buffer.
 - 3) Each binary input and output shall collect 24 change in value samples.
 - 4) Each sample shall include a time/date stamp.
 - b. For B-ASC that provide internal historical data collection, they shall provide the following:
 - 1) Each analog input shall collect 96 samples within a first-in first-out rotating buffer.
 - 2) Each binary input and output shall collect 24 change in value samples.
 - 3) Each sample shall include a time/date stamp.
 - c. Provide formatted trend report displays for each point. Include all trend data and associated parameters.
 - d. Provide preformatted commands to view and print trend reports.
- 6. Alarms:
 - a. Network Alarms
 - 1) The supervising B-BC shall monitor the local alarms within each B-ASC and shall initiate a network alarm in response.
 - 2) Supervised alarms shall conform to all alarm requirements as specified in the B-BC sections.
 - b. Local Alarms
 - 1) The B-ASC shall provide alarm monitoring for analog input values that are outside of user definable ranges and for binary output points that do not prove status.
 - 2) The user shall be able, from the operator workstation, to configure the limit ranges, limit dead-bands and to enable/disable each alarm.
 - 3) Zone temperature alarms shall have an operator adjustable alarm dead-band which shall generate a warning or alarm whenever the zone temperature is above the current active cooling set point plus the alarm dead-band or below the current active heating set point minus the alarm dead-band. Systems which do not allow linking of alarm set points with the active control set points shall not be accepted.
 - 4) The user shall be able to configure B-ASC alarms as conditional alarms that will only occur when a binary status point, physical or software, is on. This shall be used to prevent nuisance alarms during non-operating or startup modes.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Refer to 23 09 00 Installation for requirements applicable to This Section, in addition to the requirements of This Article
- B. Smoke Control:
 - 1. All systems, controllers, and networks performing Smoke Control shall be UL 864 UUKL.
- C. Local Control Panels:

1. Provide Local Control Panels to house all B-BC and B-AAC, minimum one per room, minimum one per major plant equipment such as air handling unit.
2. Install all B-AAC and B-ASC serving unitary and terminal unit equipment in control enclosures integral to the parent equipment. If no integral control enclosure exists on the parent equipment, provide Local Control Panel to house each controller.

3.02 START UP SERVICE

- A. Refer to 23 09 00 System Startup for requirements applicable to This Section

3.03 ADJUSTING

- A. Refer to 23 09 00 Adjusting for requirements applicable to This Section

3.04 CLEANING

- A. Refer to 23 09 00 Cleaning for requirements applicable to This Section

3.05 CLOSEOUT ACTIVITIES

- A. Refer to 23 09 00 Closeout Activities for requirements applicable to This Section

3.06 PROTECTION

- A. Refer to 23 09 00 Protection for requirements applicable to This Section

3.07 MAINTENANCE

- A. Refer to 23 09 00 Maintenance for requirements applicable to This Section

END OF SECTION

SECTION 23 11 23
FACILITY NATURAL-GAS PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Pipe, pipe fittings, valves, and connections for natural gas piping systems.

1.02 RELATED REQUIREMENTS

- A. Section 07 84 00 - Firestopping.
- B. Section 08 31 00 - Access Doors and Panels.
- C. Section 09 91 13 - Exterior Painting.
- D. Section 09 91 23 - Interior Painting.
- E. Section 23 05 16 - Expansion Fittings and Loops for HVAC Piping.
- F. Section 23 05 48 - Vibration and Seismic Controls for HVAC.
- G. Section 23 05 53 - Identification for HVAC Piping and Equipment.
- H. Section 26 05 83 - Wiring Connections: Electrical characteristics and wiring connections.
- I. Section 31 23 16 - Excavation.
- J. Section 31 23 16.13 - Trenching.
- K. Section 31 23 23 - Fill.
- L. Section 33 52 16 - Gas Hydrocarbon Piping.

1.03 REFERENCE STANDARDS

- A. ANSI LC 1/CSA 6.26 - Fuel Gas Piping Systems Using Corrugated Stainless Steel Tubing; 2023.
- B. ANSI Z21.18/CSA 6.3 - Gas Appliance Pressure Regulators; 2019.
- C. ANSI Z21.80/CSA 6.22 - Line Pressure Regulators; 2019.
- D. ANSI Z223.1 - National Fuel Gas Code; 2021.
- E. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators; 2025, with Errata.
- F. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300; 2021.
- G. ASME B31.1 - Power Piping; 2024.
- H. ASME B31.9 - Building Services Piping; 2020.
- I. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings; 1999, with Editorial Revision (2022).
- J. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2024.
- K. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2024.
- L. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2025.
- M. ASTM B68/B68M - Standard Specification for Seamless Copper Tube, Bright Annealed; 2025.
- N. ASTM B75/B75M - Standard Specification for Seamless Copper Tube; 2020.
- O. ASTM B813 - Standard Specification for Water Flushable Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube; 2024.

- P. ASTM D2683 - Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing; 2020.
- Q. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2024.
- R. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2025.
- S. AWWA C105/A21.5 - Polyethylene Encasement for Ductile-Iron Pipe Systems; 2018.
- T. AWWA C606 - Grooved and Shouldered Joints; 2022.
- U. ICC-ES AC01 - Acceptance Criteria for Expansion Anchors in Masonry Elements; 2018, with Editorial Revision (2020).
- V. {RSTEMP#1577}
- W. ICC-ES AC193 - Acceptance Criteria for Mechanical Anchors in Concrete Elements; 2017, with Editorial Revision (2020).
- X. ICC-ES AC308 - Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements; 2023.
- Y. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2018, with Amendment (2019).
- Z. MSS SP-78 - Gray Iron Plug Valves, Flanged and Threaded Ends; 2011.
- AA. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends; 2010, with Errata .

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.
- C. Welders' Certificates: Submit certification of welders' compliance with ASME BPVC-IX.
- D. Shop Drawings: For non-penetrating rooftop supports, submit detailed layout developed for this project, with design calculations for loadings and spacings.
- E. Sustainable Design Documentation: For soldered copper joints, submit installer's certification that the specified installation method and materials were used.
- F. Project Record Documents: Record actual locations of valves.
- G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements, for additional provisions.
 - 2. Valve Repacking Kits: One for each type and size of valve.

1.05 QUALITY ASSURANCE

- A. Perform work in accordance with applicable codes.
- B. Valves: Manufacturer's name and pressure rating marked on valve body.
- C. Welding Materials and Procedures: Comply with ASME BPVC-IX and applicable state labor regulations.
- D. Welder Qualifications: Certified in accordance with ASME BPVC-IX.
- E. Identify pipe with marking including size, ASTM material classification, and ASTM specification.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- B. Provide temporary protective coating on cast iron and steel valves.

- C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.07 FIELD CONDITIONS

- A. Do not install underground piping when bedding is wet or frozen.

PART 2 PRODUCTS

2.01 NATURAL GAS PIPING, BURIED BEYOND 5 FEET (1500 MM) OF BUILDING

- A. Steel Pipe: ASTM A53/A53M, Grade B, Type F, Schedule 40 black.
 - 1. Manufacturers:
 - a. Wheatland Tube Company; _____: www.wheatland.com/#sle.
 - 2. Fittings: ASTM A234/A234M, wrought steel welding type, with AWWA C105/A21.5 polyethylene jacket or double layer, half-lapped 10 mil (0.25 mm) polyethylene tape.
 - 3. Joints: ASME B31.1, welded.
- B. Flexible Gas Piping:
 - 1. Corrugated Stainless Steel Tubing: Comply with ANSI LC 1/CSA 6.26.
 - 2. Fittings: Provided by piping system manufacturer.
 - 3. Manufacturers:
 - a. Omega Flex, Inc; TracPipe PS-II: www.omegaflex.com/#sle.

2.02 NATURAL GAS PIPING, BURIED WITHIN 5 FEET (1500 MM) OF BUILDING

- A. Steel Pipe: ASTM A53/A53M, Grade B, Type F, Schedule 40 black.
 - 1. Manufacturers:
 - 2. Fittings: ASTM A234/A234M, wrought steel welding type.
 - 3. Joints: ANSI Z223.1, welded.
 - 4. Jacket: AWWA C105/A21.5 polyethylene jacket or double layer, half-lapped 10 mil (0.25 mm) polyethylene tape.
- B. Flexible Gas Piping:
 - 1. Corrugated Stainless Steel Tubing: Comply with ANSI LC1 / CSA 6.26.
 - 2. Fittings: Provided by piping system manufacturer.
 - 3. Manufacturers:
 - a. Omega Flex, Inc; TracPipe PS-II: www.omegaflex.com/#sle.

2.03 NATURAL GAS PIPING, ABOVE GRADE

- A. Steel Pipe: ASTM A53/A53M, Grade B, Type F, Schedule 40 black.
 - 1. Manufacturers:
 - a. Wheatland Tube Company; _____: www.wheatland.com/#sle.
 - 2. Fittings: ASME B16.3, malleable iron, or ASTM A234/A234M, wrought steel welding type.
 - 3. Joints: Threaded or welded to ASME B31.1.
- B. Flexible Gas Piping:
 - 1. Corrugated Stainless Steel Tubing: Comply with ANSI LC 1/CSA 6.26.
 - 2. Comply with ASTM E84.
 - 3. Fittings: Provided by piping system manufacturer.
 - 4. Provide piping with integral lightning protection.
 - 5. Manufacturers:
 - a. Omega Flex, Inc; TracPipe CounterStrike: www.omegaflex.com/#sle.

2.04 FLANGES, UNIONS, AND COUPLINGS

- A. Unions for Pipe Sizes 3 Inches (80 mm) and Under:
 - 1. Ferrous Pipe: Class 150 malleable iron threaded unions.

- B. Flanges for Pipe Size Over 1 Inch (25 mm):
 - 1. Ferrous Pipe: Class 150 malleable iron threaded or forged steel slip-on flanges; preformed neoprene gaskets.
- C. Mechanical Couplings for Grooved and Shouldered Joints: Two or more curved housing segments with continuous key to engage pipe groove, circular C-profile gasket, and bolts to secure and compress gasket.
 - 1. Dimensions and Testing: In accordance with AWWA C606.
 - 2. Housing Material: Provide ASTM A47/A47M malleable iron, ductile iron, or _____, galvanized.
 - 3. Gasket Material: EPDM suitable for operating temperature range from minus 30 degrees F (minus 34 degrees C) to 230 degrees F (110 degrees C).
 - 4. Bolts and Nuts: Hot dipped galvanized or zinc-electroplated steel.
 - 5. When pipe is field grooved, provide coupling manufacturer's grooving tools.
 - 6. Manufacturers:
 - a. Apollo Valves; _____: www.apollovalves.com/#sle.
 - b. Grinnell Products; _____: www.grinnell.com/#sle.
- D. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

2.05 PIPE HANGERS AND SUPPORTS

- A. Provide hangers and supports that comply with MSS SP-58.
 - 1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
 - 2. Overhead Supports: Individual steel rod hangers attached to structure or to trapeze hangers.
 - a. Cold and Hot Pipe Sizes 6 Inches (150 mm) and Over: Double hangers.
 - 3. Trapeze Hangers: Welded steel channel frames attached to structure.
 - 4. Vertical Pipe Support: Steel riser clamp.
 - 5. Floor Supports: Concrete pier or steel pedestal with floor flange; fixture attachment.
- B. Hanger Fasteners: Attach hangers to structure using appropriate fasteners, as follows:
 - 1. Concrete Wedge Expansion Anchors: Complying with ICC-ES AC193.
 - 2. Masonry Wedge Expansion Anchors: Complying with ICC-ES AC01.
 - 3. Concrete Screw Type Anchors: Complying with ICC-ES AC193.
 - 4. Masonry Screw Type Anchors: Complying with {RS#1577}.
 - 5. Concrete Adhesive Type Anchors: Complying with ICC-ES AC308.
 - 6. Other Types: As required.
 - 7. Manufacturers:
 - a. Powers Fasteners, Inc; _____: www.powers.com/#sle.

2.06 BALL VALVES

- A. Manufacturers:
 - 1. Apollo Valves; _____: www.apollovalves.com/#sle.
 - 2. Effebi; Gladiator: www.effebi.com/#sle.
 - 3. Grinnell Products; _____: www.grinnell.com/#sle.
 - 4. Milwaukee Valve Company; _____: www.milwaukeevalve.com/#sle.
 - 5. Nibco, Inc; _____: www.nibco.com/#sle.
- B. Construction, 4 Inches (100 mm) and Smaller: MSS SP-110, Class 150, 400 psi (2760 kPa) CWP, brass, bronze, or ductile iron body, 304 stainless steel or chrome plated brass ball, regular port, Teflon seats and stuffing box ring, blowout proof stem, lever handle with balancing stops, solder, threaded, or grooved ends with union.

2.07 STRAINERS

- A. Manufacturers:
 - 1. Armstrong International, Inc; _____: www.armstronginternational.com/#sle.
 - 2. Green Country Filter Manufacturing; _____: www.greencountryfilter.com/#sle.
 - 3. WEAMCO; _____: www.weamco.com/#sle.
- B. Size 2 inch (50 mm) and Under:
 - 1. Threaded brass body for 175 psi (1200 kPa) CWP, Y pattern with 1/32 inch (0.8 mm) stainless steel perforated screen.
 - 2. Class 150, threaded bronze body 300 psi (2070 kPa) CWP, Y pattern with 1/32 inch (0.8 mm) stainless steel perforated screen.
- C. Size 1-1/2 inch (40 mm) to 4 inch (100 mm):
 - 1. Class 125, flanged iron body, Y pattern with 1/16 inch (1.6 mm) stainless steel perforated screen.

2.08 LINE PRESSURE REGULATORS AND APPLIANCE REGULATORS INDICATORS

- A. Manufacturers:
 - 1. Actaris Metering Systems (A brand of ITT Controls); _____: www.actaris-metering-systems.com/#sle.
 - 2. Dungs Combustion Controls; _____: www.dungs.com/#sle.
 - 3. Maxitrol Company; _____: www.maxitrol.com/#sle.
- B. Compliance Requirements:
 - 1. Appliance Regulator: ANSI Z21.18/CSA 6.3.
 - 2. Line Pressure Regulator: ANSI Z21.80/CSA 6.22.
- C. Materials in Contact With Gas:
 - 1. Housing: Aluminum, steel (free of non-ferrous metals).
 - 2. Seals and Diaphragms: NBR-based rubber.
- D. Maximum Inlet Operating Pressure: 10 psi (68.9 kPa).
 - 1. Appliance Regulator: 10 psi (68.9 kPa).
 - 2. Line Pressure Regulator: 10 psi (68.9 kPa).
- E. Maximum Body Pressure: 10 psi (1000 mbar).
- F. Output Pressure Range: 1 inch wc (2.5 mbar) to 80 inch wc (200 mbar).

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that excavations are to required grade, dry, and not over-excavated.

3.02 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt, on inside and outside, before assembly.
- C. Prepare piping connections to equipment with flanges or unions.

3.03 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide non-conducting dielectric connections wherever jointing dissimilar metals.
- C. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.
- D. Install piping to maintain headroom, conserve space, and not interfere with use of space.
- E. Group piping whenever practical at common elevations.
- F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 23 05 16.

- G. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.
- H. Provide access where valves and fittings are not exposed.
 - 1. Coordinate size and location of access doors with Section 08 31 00.
- I. Install vent piping penetrating roofed areas to maintain integrity of roof assembly; refer to Section ____.
- J. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
- K. Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting.
 - 1. Painting of interior piping systems and components is specified in Section 09 91 23.
 - 2. Painting of exterior piping systems and components is specified in Section 09 91 13.
- L. Excavate in accordance with Section 31 23 16.
- M. Install valves with stems upright or horizontal, not inverted.
- N. Pipe vents from gas pressure reducing valves to outdoors and terminate in weather proof hood.
- O. Sleeve pipes passing through partitions, walls and floors.
- P. Inserts:
 - 1. Provide inserts for placement in concrete formwork.
 - 2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 - 3. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
 - 4. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.
- Q. Pipe Hangers and Supports:
 - 1. Install in accordance with ASME B31.9.
 - 2. Support horizontal piping as indicated.
 - 3. Install hangers to provide minimum 1/2 inch (15 mm) space between finished covering and adjacent work.
 - 4. Place hangers within 12 inches (300 mm) of each horizontal elbow.
 - 5. Use hangers with 1-1/2 inch (40 mm) minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
 - 6. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
 - 7. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

3.04 APPLICATION

- A. Install unions downstream of valves and at equipment or apparatus connections.
- B. Install ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.
- C. Install ball valves for throttling, bypass, or manual flow control services.
- D. Provide plug valves in natural gas systems for shut-off service.

3.05 SERVICE CONNECTIONS

- A. Provide new gas service complete with gas meter and regulators in accordance with Section 33 52 16. Gas service distribution piping to have initial minimum pressure of 7 inch wg (1.75 kPa). Provide regulators on each line serving gravity type appliances, sized in accordance with equipment.

3.06 SCHEDULES

- A. Pipe Hanger Spacing:

1. Metal Piping:
 - a. Pipe Size: 1/2 inches (15 mm) to 1-1/4 inches (32 mm):
 - 1) Maximum Hanger Spacing: 6.5 ft (2 m).
 - 2) Hanger Rod Diameter: 3/8 inches (9 mm).
 - b. Pipe Size: 1-1/2 inches (40 mm) to 2 inches (50 mm):
 - 1) Maximum Hanger Spacing: 10 ft (3 m).
 - 2) Hanger Rod Diameter: 3/8 inch (9 mm).
 - c. Pipe Size: 2-1/2 inches (65 mm) to 3 inches (75 mm):
 - 1) Maximum Hanger Spacing: 10 ft (3 m).
 - 2) Hanger Rod Diameter: 1/2 inch (13 mm).
 - d. Pipe Size: 4 inches (100 mm) to 6 inches (150 mm):
 - 1) Maximum Hanger Spacing: 10 ft (3 m).
 - 2) Hanger Rod Diameter: 5/8 inch (15 mm).

END OF SECTION

**SECTION 23 21 13
HYDRONIC PIPING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Hydronic Piping, Above Grade.
 - 1. Steel Pipe
 - a. Steel Pipe Sizes 10" and Smaller
 - b. Steel Pipe Sizes 12" and Larger
 - 2. Copper Tube
 - 3. Pressure-Rated Polypropylene Pipe
 - 4. Cross-Linked Polyethylene (PEX) Pipe
 - 5. Grooved Mechanical Joint Fittings
- B. Radiant Heating Piping.
 - 1. Copper Tube
 - 2. Cross-Linked Polyethylene (PEX) Pipe
 - 3. Composite Polyethylene Pipe
 - 4. Hose
- C. Equipment Drains and Overflows.
 - 1. Copper Tube
 - 2. PVC Pipe
 - 3. ABS Pipe
- D. Refrigerant Piping.
 - 1. Packaged Ball Valves
 - 2. Flexible Connectors
- E. Pipe Hangers and Supports.
- F. Unions, Flanges, Mechanical Couplings, and Dielectric Connections.
 - 1. Unions for Pipes 2" and Less
 - 2. Flanges for Pipes 2" and Larger
 - 3. Mechanical Couplings for Grooved and Shouldered Joints
 - 4. Dielectric Connections
- G. Thrust Blocking and Anchors for Underground Hydronic Piping.

1.02 GENERAL REFERENCES

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.
- B. Division 20, including all Common Mechanical Requirements in Section 20 00 00, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.

1.03 REFERENCE STANDARDS

- A. ASHRAE Std 15 - Safety Standard for Refrigeration Systems; 2024, with Errata (2025).
- B. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300; 2021.
- C. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24 Metric/Inch Standard; 2025.
- D. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2021.
- E. {RSTEMP#367}
- F. ASME B16.39 - Malleable Iron Threaded Pipe Unions: Classes 150, 250, and 300; 2019.

- G. ASME B31.5 - Refrigeration Piping and Heat Transfer Components; 2022.
- H. ASME B31.9 - Building Services Piping; 2020.
- I. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators; 2025, with Errata.
- J. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings; 1999, with Editorial Revision (2022).
- K. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2024.
- L. ASTM A106/A106M - Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service; 2019a.
- M. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2024.
- N. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2025.
- O. ASTM A536 - Standard Specification for Ductile Iron Castings; 2024.
- P. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2022.
- Q. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric); 2020.
- R. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Services; 2022.
- S. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120; 2021a.
- T. ASTM D2241 - Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series); 2025.
- U. ASTM D2680 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Composite Sewer Piping; 2020 (Reapproved 2025).
- V. ASTM D2774 - Standard Practice for Underground Installation of Thermoplastic Pressure Piping; 2021a.
- W. ASTM D2855 - Standard Practice for the Two-Step (Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets; 2020 (Reapproved 2024).
- X. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers; 2024.
- Y. ASTM F876 - Standard Specification for Crosslinked Polyethylene (PEX) Tubing; 2024b.
- Z. ASTM F877 - Standard Specification for Crosslinked Polyethylene (PEX) Hot- and Cold-Water Distribution Systems; 2024.
- AA. ASTM F1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications; 2007 (Reapproved 2024).
- BB. ASTM F2389 - Standard Specification for Pressure-Rated Polypropylene (PP) Piping Systems; 2023.
- CC. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding; 2019.
- DD. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2025.
- EE. AWWA C606 - Grooved and Shouldered Joints; 2022.
- FF. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2018, with Amendment (2019).

GG. UL 207 - Standard for Refrigerant-Containing Components and Accessories, Nonelectrical; Current Edition, Including All Revisions.

HH. {RSTEMP#2109}

1.04 SUBMITTALS

A. Action Submittals

1. Welders Certificate: Include welders certification of compliance with ASME BPVC-IX; AWS D1.1/D1.1M.
2. Product Data:
 - a. Include data on pipe materials, pipe fittings, and accessories.
 - b. Provide manufacturer's catalog information.
 - c. Show grooved joint couplings, fittings, valves, and specialties on drawings and product submittals, specifically identified with the manufacturer's style or series designation.
3. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.
4. Field Test Reports: Written reports of tests specified in Part 3 of this Section, including:
 - a. Test procedures.
 - b. Failed test results and corrective action taken to achieve requirements.
 - c. Test results that comply with requirements.
5. Water Analysis: Submit a copy of the water analysis to illustrate water quality available at project site.

B. Operation and Maintenance Materials

1. Include installation instructions, spare parts lists, exploded assembly views.

C. Record Documents

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications:** Company specializing in manufacturing products of the type specified in this section, with minimum three years of experience.
- B. Installer Qualifications:** Company specializing in performing work of the type specified in this section, with a minimum three years of experience.
- C.** Provide all grooved joint couplings, fittings, valves, specialties, and grooving tools from a single manufacturer.
- D.** Date stamp all castings used for coupling housings, fittings, valve bodies, etc. for quality assurance and traceability.
- E. Coupling Manufacturer:**
1. Perform on-site training by factory-trained representative to the Contractor's field personnel in the proper use of grooving tools and installation of grooved joint products.
 2. Periodic job site visits by factory-trained representative to ensure best practices in grooved joint installation.
 3. A distributor's representative is not considered qualified to perform the training.
- F. Welder Qualifications:** Certify in accordance with ASME BPVC-IX; AWS D1.1/D1.1M.
1. Provide a certificate from authority having jurisdiction indicating approval of welders.
- G. Refrigerant Piping**
1. Welding: Qualify procedures and personnel according to ASME BPVC-IX "Welding and Brazing Qualifications."
 2. ASHRAE Standard: Comply with ASHRAE Std 15, "Safety Code for Mechanical Refrigeration."
 3. ASME Standard: Comply with ASME B31.5, "Refrigeration Piping."

4. UL Standard: Provide products complying with UL 207, "Refrigerant-Containing Components and Accessories, Nonelectrical" or {RS#2109} "Electrically Operated Valves."

1.06 DELIVERY, STORAGE AND HANDLING

- A. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- B. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 PRODUCTS

2.01 GENERAL

- A. Hydronic System Requirements
 1. Comply with ASME B31.9 and applicable federal, state, and local regulations.
 2. Piping: Provide piping, fittings, hangers, and supports as required, as indicated, and as follows:
 - a. Where more than one piping system material is specified, provide joining fittings that are compatible with piping materials and ensure that the integrity of the system is not jeopardized.
 - b. Use non-conducting dielectric connections whenever jointing dissimilar metals.
 - c. Provide pipe hangers and supports in accordance with ASME B31.9; MSS SP-58; unless indicated otherwise.
 3. Pipe-to-Valve and Pipe-to-Equipment Connections: Use flanges, unions, grooved couplings (where specified for pipe) to allow disconnection of components for servicing; do not use direct welded, soldered, or threaded connections.
 - a. Where grooved joints are used in piping, provide grooved valve/equipment connections if available; if not available, provide flanged ends and grooved flange adapters.

2.02 HYDRONIC PIPING, ABOVE GRADE

- A. Steel Pipe:
 1. Steel Pipe Sizes 10 inch and smaller: ASTM A53/A53M, Schedule 40, black, using one of the following joint types:
 - a. Welded Joints: ASTM A234/A234M, wrought steel welding type fittings; AWS D1.1/D1.1M welded.
 - b. Threaded Joints: ASME B16.3, malleable iron fittings.
 - c. Grooved Joints: AWWA C606 grooved pipe, fittings of same material, and mechanical couplings.
 2. Steel Pipe Sizes 12 inch (305 mm) and Greater: ASTM A53/A53M, 3/8 inch (9.5 mm) wall, black, using one of the following joint types:
- B. Copper Tube: ASTM B88 (ASTM B88M), Type K drawn, using one of the following joint types:
 1. Solder Joints: ASME B16.18 cast brass/bronze or {RS#367} solder wrought copper fittings.
 - a. Solder: ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver for pipes smaller than 2-1/2 inches.
 - b. Braze: AWS A5.8M/A5.8 BCuP copper/silver alloy pipes 2-1/2-inches or larger or piping routed above operating rooms, delivery rooms, cesarean rooms, recovery rooms, special procedure rooms, nurseries, intensive care units, food storage and preparation areas, computer rooms, telecommunication rooms, electrical rooms, or IDF/MDF rooms.
- C. Pressure-Rated Polypropylene Pipe: ASTM D2774 or ASTM F2389, PP-RCT resin pipe with fiber layer, SDR 11.
 1. Manufacturers:

- D. Cross-Linked Polyethylene (PEX) Pipe: ASTM F876 or ASTM F877.
 - 1. Manufacturers:
- E. Grooved Mechanical Joint Fittings: ASTM A536, Grade 65-45-12 ductile iron; ASTM A47/A47M, Grade 32510 malleable iron; ASTM A53/A53M, Type F, E, or S, Grade B fabricated steel; or, ASTM A106/A106M, Grade B steel fittings with grooves or shoulders designed to accept grooved end couplings. Cut-groove piping is not acceptable.
 - 1. Grooved Mechanical-Joint Couplings: Ductile or malleable iron housing and synthetic rubber gasket of central cavity pressure-responsive design for operating temperature range from -30 degrees F to 230 degrees F. Gasket material as recommended by manufacturer for design conditions.
 - a. Manufacturers:
 - 1) Anvil International
 - 2) Shurjoint Piping Products
 - 3) Victaulic
 - 4) Grinnell Mechanical Products

2.03 RADIANT HEATING PIPING

- A. Copper Tube: ASTM B88 (ASTM B88M), Type K annealed.
 - 1. Fittings: {RS#367}, wrought copper.
 - 2. Mechanical Press Sealed Fittings: Double pressed type complying with {RS#367}, utilizing EPDM, non toxic synthetic rubber sealing elements.
 - a. Manufacturers:
 - 1) FNW; Copper Press: www.fnw.com/#sle.
 - 3. Joints: Solder, lead free, ASTM B32 HB alloy (95-5 tin-antimony), or tin and silver.
- B. Cross-Linked Polyethylene (PEX) Pipe: ASTM F876 or ASTM F877 .
 - 1. Manufacturers:
- C. Composite Polyethylene Pipe: Aluminum tube laminated between two layers of high density polyethylene.
- D. Hose: Composite hose with nitrile liner, braided fiber reinforcing, neoprene cover, 150 psig (1034 kPa) operating pressure at 205 degrees F (96 degrees C).
 - 1. Fittings: Copper.
 - 2. Joints: Nipple with stainless steel clamp.

2.04 EQUIPMENT DRAINS AND OVERFLOWS

- A. Copper Tube: ASTM B88 (ASTM B88M), Type L drawn; using one of the following joint types:
 - 1. Solder Joints: ASME B16.18 cast brass/bronze or {RS#367} solder wrought copper fittings; ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.
- B. PVC Pipe: ASTM D1785, Schedule 40, or ASTM D2241, SDR 21 or 26.
- C. ABS Pipe: ASTM D2680.

2.05 REFRIGERANT PIPING

- A. Refer to 23 23 00
- B. Copper Tube: Type ACR, annealed-temper tube, clean, dry and capped.
 - 1. Fittings: {RS#367} wrought copper.
 - 2. Joints: Braze, AWS A5.8M/A5.8 BCuP silver/phosphorus/copper alloy (15 percent Silver).
- C. Packaged Ball Valves: Two piece bolted forged brass body with Teflon ball seals and copper tube extensions, brass seal cap, chrome plated ball, stem with neoprene ring stem seals; for maximum working pressure of and maximum temperature of 300 degrees F.
- D. Flexible Connectors: Provide stainless steel refrigerant flexible connector with copper ends, operating at 700 psi, cleaned and bagged per PRAXAIR 99.

2.06 PIPE HANGERS AND SUPPORTS

- A. In grooved installations, use rigid couplings with offsetting angle-pattern bolt pads or with wedge-shaped grooves in header piping to permit support and hanging in accordance with ASME B31.9.
- B. Rooftop Supports for Low-Slope Roofs: Steel pedestals with bases that rest on top of roofing membrane, not requiring any attachment to the roof structure and not penetrating the roofing assembly, with support fixtures as specified; and as follows:
 - 1. Bases: High-density polypropylene.
 - 2. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
 - 3. Steel Components: Stainless steel or carbon steel hot-dip galvanized after fabrication in accordance with ASTM A123/A123M.
 - 4. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports; corrosion-resistant material.
 - 5. Height: Provide minimum clearance of 24 inches (600 mm) under pipe to top of roofing.
 - 6. Manufacturers:
 - a. PHP Systems/Design: www.phpsd.com/#sle.
 - b. Dura Blok.
 - c. Rooftop Blox.
- C. Refer to Section 20 05 48 - Vibration and Seismic Controls for additional requirements.

2.07 UNIONS, FLANGES, MECHANICAL COUPLINGS, AND DIELECTRIC UNIONS

- A. Unions for Pipe of 2 Inches (50 mm, DN) and Less:
 - 1. Ferrous Piping: 150 psi, threaded, ASME B16.39.
 - 2. Copper Pipe: Bronze, soldered joints.
- B. Flanges for Pipe 2 Inches (50 mm, DN) and Greater:
 - 1. Ferrous Piping: 150 psi forged steel, slip-on.
 - 2. Copper Piping: Bronze.
 - 3. Gaskets: 1/16 inch (1.6 mm) thick, preformed neoprene.
- C. Mechanical Couplings for Grooved and Shouldered Joints: Two or more curved housing segments with continuous key to engage pipe groove, circular C-profile gasket, and bolts to secure and compress gasket.
 - 1. Dimensions and Testing: In accordance with AWWA C606.
 - 2. Mechanical Couplings: Comply with ASTM F1476.
 - 3. Housing Material: Ductile iron; galvanized; complying with ASTM A536.
 - 4. Gasket Material: EPDM suitable for operating temperature range from minus minus 30 degrees F (minus 34 degrees C) to 230 degrees F (110 degrees C).
 - 5. Gasket Material for glycol systems operating below 140 degrees F (60 degrees C): Nitrile rubber suitable for operating temperature range from minus 20 degrees F to 180 F (minus 29 degrees C to 82 degrees C).
 - 6. Bolts and Nuts: Hot dipped galvanized or zinc-electroplated steel.
 - 7. When pipe is field grooved, provide coupling manufacturer's grooving tools.
 - 8. Manufacturers:
 - a. Anvil International.
 - b. Shurjoint Piping Products, Inc.
 - c. Victaulic Company: www.victaulic.com/#sle.
 - d. Central Sprinkler Company.
 - e. Grinnell Mechanical Products.
- D. Dielectric Connections: Provide dielectric waterway or dielectric flange fittings.
 - 1. Waterways:

- a. Water impervious insulation barrier capable of limiting galvanic current to 1 percent of short circuit current in a corresponding bimetallic joint.
 - b. Dry insulation barrier able to withstand 600-volt breakdown test.
 - c. Construct of galvanized steel with threaded end connections to match connecting piping.
 - d. Suitable for the required operating pressures and temperatures.
2. Flanges:
- a. Dielectric flanges with same pressure ratings as standard flanges.
 - b. Water impervious insulation barrier capable of limiting galvanic current to 1 percent of short circuit current in a corresponding bimetallic joint.
 - c. Dry insulation barrier able to withstand 600-volt breakdown test.
 - d. Construct of galvanized steel with threaded end connections to match connecting piping.
 - e. Suitable for the required operating pressures and temperatures.

PART 3 EXECUTION

3.01 APPLICATION

- A. Select system components with pressure rating equal to or greater than system operating pressure.
- B. Install hydronic piping in accordance with the following:

Service	Above Grade			Above Grade Inside Shafts			Below Grade Preinsulated			Below Grade Uninsulated	
	W/S	GC	Cu	W	Cu	___	W	Cu	___	W	Cu
Chilled Water	X	X	X	X	X		X	X		N/A	N/A
Heating Hot Water	X		X	X	X		X	X		N/A	N/A
Condenser Water	X	X	X	X	X		N/A	N/A		X	N/A

Legend:

W/S: Welded or Screwed, Steel

W: Welded Steel

GC: Grooved Coupling, Steel

Cu: Copper

N/A: Not Acceptable or Not Applicable

- C. Install other piping as follows:
 1. Makeup-water piping installed aboveground: Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
 2. Makeup-Water Piping Installed below ground: Type K, annealed-temper copper tubing, wrought-copper fittings, and soldered joints. Use the fewest possible joints.
 3. Condensate-Drain Piping: Type DWV, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
 4. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.
 5. Air-vent piping:
 - a. Inlet: Same material as service where installed, with metal-to-plastic transition fittings for plastic piping systems according to piping manufacturer's written instructions.
 - b. Outlet: Type K, annealed-temper copper tubing with soldered or flared joints.

6. Safety Valve Inlet and Outlet Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed, with metal-to-plastic transition fittings for plastic piping systems according to piping manufacturer's written instructions.

3.02 EXAMINATION

3.03 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Prepare pipe for grooved mechanical joints as required by coupling manufacturer.
- C. Remove scale and dirt on inside and outside before assembly.
- D. Prepare piping connections to equipment using jointing system specified.
- E. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.
- F. After completion, fill, clean, and treat systems. See Section 23 25 00 - HVAC Water Treatment for additional requirements.
- G. Prepare unfinished pipe, fittings, supports, and accessories, ready for finish painting. See Section 09 91 23 - Interior Painting.

3.04 INSTALLATION

- A. General
 1. Install in accordance with manufacturer's written instructions and requirements.
 2. Drawings indicate general location and arrangement of piping systems. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
 3. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
 4. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
 5. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
 6. Install piping to permit valve servicing.
 7. Install piping at a uniform grade of 0.2 percent upward in direction of flow, unless indicated on drawings.
 8. Install piping to allow application of insulation.
 9. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
 10. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.
 11. Install air vents and pressure-relief valves in accordance with Section 23 21 14 - Hydronic Specialties.
 12. Install sleeves for piping penetrations of walls, ceilings, and floors.
 13. Install sleeve seals for piping penetrations of concrete walls and slabs.
 14. Install escutcheons for piping penetrations of walls, ceilings, and floors.
 15. Install heating water, glycol, chilled water, and condenser water, to ASME B31.9 requirements.
 16. Route piping in orderly manner, parallel to building structure, and maintain gradient.
 17. Install piping to conserve building space and to avoid interference with use of space.
 18. Group piping whenever practical at common elevations.
 19. Sleeve pipe passing through partitions, walls, and floors.
 20. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 078400 - Firestopping.
 21. Slope piping and arrange to drain at low points.

22. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. See Section 20 05 16 - Expansion Fittings and Loops for Mechanical Piping.
 - a. Flexible couplings may be used in header piping to accommodate thermal growth, thermal contraction in lieu of expansion loops.
 - b. Use flexible couplings in expansion loops.
 23. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. See Section 200719 - Mechanical Piping Insulation.
 24. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with Section 08 31 00 - Access Doors and Panels.
 25. Use eccentric reducers to maintain top of pipe level.
 26. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc-rich primer to welds.
- B. PVC Pipe: Make solvent-welded joints in accordance with ASTM D2855.
- C. PP-RCT Pipe: Make heat fusion joint per manufacturers instructions.
- D. Grooved Joints:
1. Install in accordance with the manufacturer's latest published installation instructions.
 2. Gaskets to be suitable for the intended service, molded, and produced by the coupling manufacturer.
- E. Inserts:
1. Provide inserts for placement in concrete formwork.
 2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over inches (100 mm).
 4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
 5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.
- F. Equipment Drains and Overflows
1. Install drains, consisting of a tee fitting, 3/4 inch (20 mm) ball valve, and short 3/4 inch (20 mm) threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
- G. Unions, Flanges, Mechanical Couplings, and Dielectric Unions
1. Unions
 - a. Install unions in piping, 3/4 inch (50 mm) and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
 2. Flanges
 - a. Install flanges in piping, 2-1/2 inch (65 mm) and larger, at final connections of equipment and elsewhere as indicated.
 3. Dielectric Fittings
 - a. Install shutoff valve immediately upstream of each dielectric fitting.
 - b. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
 - c. Dielectric Fittings for pipe sizes 4 inch (100 mm) and Smaller: Use dielectric waterways.
 - d. Dielectric Fittings for pipe sizes 5 inch (125 mm) and larger: Use dielectric flange kits.
 - e. Dielectric Unions or Dielectric Nipples are not acceptable.
- H. Pipe Hangers and Supports:
1. Install in accordance with ASME B31.9; ASTM F708; MSS SP-58.
 2. Support horizontal piping as scheduled.

3. Install hangers to provide minimum 1/2 inch (13 mm) space between finished covering and adjacent work.
4. Place hangers within 12 inch (300 mm) of each horizontal elbow.
5. Use hangers with 1-1/2 inch (38 mm) minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
6. Support vertical piping at every other floor but not more than 10 feet. Support riser piping independently of connected horizontal piping.
7. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
8. Provide copper plated hangers and supports for copper piping.
9. Prime coat exposed steel hangers and supports. See Section 09 91 23 - Interior Painting. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

3.05 FLUSHING AND CLEANING OF PIPING SYSTEMS

- A. Clean piping systems thoroughly. Purge pipe of construction debris and contamination before placing the piping systems in service. Provide temporary connections for cleaning, purging, and circulating fluids through the piping system.
- B. Use temporary strainers and temporary pumps that can create fluid velocities up to 10 feet per second to flush and clean the piping systems. Do not use Owner's permanent strainers to trap debris during pipe flushing operations. Fit the temporary construction strainers with a line size blowoff valve.
- C. When constructing minor piping modifications or additions verify with Owner if the Owner's pumps and strainers can be used for flushing and chemical cleaning operations. When the flushing and cleaning operations are complete, ensure the strainer baskets and screens installed in the piping systems permanent strainers are replaced with clean elements. Keep temporary strainers in service until the equipment has been tested, then replace straining element with a new strainer and clean and deliver the old straining elements to Owner. Fit the Owner's strainers with a line size blowoff valve.
- D. Install bypass piping or hoses at the supply and return piping connections at heat exchangers, chillers, boilers, heat pumps, cooling towers, pumps, terminal unit reheat coils and cooling coils, etc., to prevent debris from being caught or causing damage to equipment which will be connected to the piping system.
- E. Circulate a chemical cleaner in hydronic water piping systems to remove mill scale, grease, oil, and silt. Cleaner to be selected by chemical treatment vendor on project. Circulate for 48 hours, flush system and replace with clean water. Dispose of chemical solution in accordance with local codes. The hydronic water system should then be treated with chemicals and inhibitors to be selected by chemical treatment vendor on project. When the chemical cleaning is complete, remove, clean, and reinstall all permanent screens. Notify Owner so that the reinstallation of clean strainer screens may be witnessed.
- F. Do not fill hydronic/water piping systems without chemical treatment and circulation of water.
- G. SBISD personnel shall witness the system flush.

END OF SECTION

SECTION 23 21 14
HYDRONIC SPECIALTIES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Expansion tanks.
- B. Air vents.
- C. Air separators.
- D. Hydraulic separators.
- E. Dirt separators.
- F. Strainers.
- G. Suction diffusers.
- H. Combination pump discharge valves.
- I. Pressure-temperature test plugs.
- J. Balancing valves.
- K. Automatic flow control valves.
- L. Flow meters.
- M. Relief valves.
- N. Pressure reducing valves.
- O. Glycol system.
- P. Vacuum deaerators.

1.02 RELATED REQUIREMENTS

- A. Section 22 10 06 - Plumbing Piping Specialties: Backflow preventers.
- B. Section 23 21 13 - Hydronic Piping.
- C. Section 23 25 00 - HVAC Water Treatment: Pipe cleaning.

1.03 REFERENCE STANDARDS

- A. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250; 2020.
- B. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24 Metric/Inch Standard; 2025.
- C. ASME B16.11 - Forged Fittings, Socket-Welding and Threaded; 2021.
- D. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1: Rules for Construction of Pressure Vessels; 2025, with Errata .

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide product data for manufactured products and assemblies required for this project. Include component sizes, rough-in requirements, service sizes, and finishes. Include product description and model.
- C. Certificates: Inspection certificates for pressure vessels from authority having jurisdiction.
- D. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.
- E. Maintenance Contract.
- F. Project Record Documents: Record actual locations of flow controls.

- G. Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.
- H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements for additional provisions.
 - 2. Extra Glycol Solution: One container, 1 gallon (4 L) size.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- B. Provide temporary protective coating on cast iron and steel valves.
- C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 PRODUCTS

2.01 EXPANSION TANKS

- A. Manufacturers:
 - 1. Amtrol Inc; _____: www.amtrol.com/#sle.
 - 2. Bell & Gossett, a brand of Xylem, Inc; _____: www.bellgossett.com/#sle.
 - 3. Taco, Inc; _____: www.taco-hvac.com/#sle.
- B. Maximum Rated Working Pressure: 125 psi (860 kPa).
- C. Maximum Allowable Service Temperature: 240 degrees F (115.6 degrees C).
- D. Construction: Welded steel, tested and stamped in accordance with ASME BPVC-VIII-1; supplied with National Board Form U-1, adjustable flexible EPDM diaphragm or bladder seal factory precharged to 12 psi (80 kPa), and steel support stand.
- E. Automatic Cold Water Fill Assembly: Pressure reducing valve, reduced pressure double check backflow preventer, test cocks, strainer, vacuum breaker, and valved by-pass.
- F. Accessories: Provide air-charging fitting, bulls eye sight glass, pressure gauge, and tank drain ball valve.

2.02 AIR VENTS

- A. Manufacturers:
 - 1. Armstrong International, Inc; _____: www.armstronginternational.com/#sle.
 - 2. Bell & Gossett, a brand of Xylem, Inc; _____: www.bellgossett.com/#sle.
 - 3. Taco, Inc; _____: www.taco-hvac.com/#sle.
- B. Manual Air Vent: Short vertical sections of 2-inch (50 mm, DN) diameter pipe to form air chamber, with 1/8 inch (6 mm, DN) brass needle valve at top of chamber.
- C. Float Air Vent:
 - 1. Brass or semi-steel body, copper, polypropylene, or solid non-metallic float, stainless steel valve and valve seat; suitable for system operating temperature and pressure; with isolating valve.
- D. Hygroscopic Air Vent:
 - 1. Brass with hygroscopic fiber discs, vent ports, adjustable cap for manual shut-off, and integral spring-loaded ball check valve.
- E. Maximum Fluid Pressure: 150 psi (1,034 kPa).

F. Maximum Fluid Temperature: 250 degrees F (121.1 degrees C).

2.03 AIR SEPARATORS

A. In-line Air Separators:

1. Manufacturers:
 - a. Armstrong International, Inc; _____: www.armstronginternational.com/#sle.
 - b. Bell & Gossett, a brand of Xylem, Inc; _____: www.bellgossett.com/#sle.
 - c. Flamco: www.flamcogroup.us/#sle.
 - d. Taco, Inc; _____: www.taco-hvac.com/#sle.
2. Cast iron for sizes 1-1/2 inch (40 mm, DN) and smaller, or steel for sizes 2 inch (50 mm, DN) and larger; tested and stamped in accordance with ASME BPVC-VIII-1; for 125 psi (860 kPa) operating pressure.
3. Maximum Allowable Service Temperature: 450 degrees F (232.2 degrees C).
4. Accessories: Provide epoxy coating finish, drain ball valve, and removable strainer.
5. Brass combined with high-grade plastics, 3/4 to 2 inch (20 to 50 mm, DN) rotating female threaded connection for use with cold water, hot water, and glycol mixes with maximum working pressure of 145 psi (1,000 kPa) over a temperature range of 14 to 248 degrees F (minus 10 to 120 degrees C).

B. Coalescing Air/Dirt Separators:

1. Manufacturers:
 - a. Armstrong International, Inc; _____: www.armstronginternational.com/#sle.
 - b. Bell & Gossett, a brand of Xylem, Inc; _____: www.bellgossett.com/#sle.
 - c. Flamco: www.flamcogroup.us/#sle.
 - d. Spirotherm, Inc; _____: www.spirotherm.com/#sle.
2. Tank: Fabricated steel tank; tested and stamped in accordance with ASME BPVC-VIII-1 for maximum fluid service subject to application requirements and manufacturer's standard maximum operating conditions.
3. Coalescing Medium: Provide structured copper or stainless steel medium filling the entire vessel to suppress turbulence and provide air elimination efficiency of 100 percent free air, 100 percent entrained air, and 99.6 percent dissolved air at the installed location.
4. Air Vent: Integral float actuated air vent at top fitting of tank rated at 150 psi (1,034 kPa), threaded to top of separator.
5. End Connections: Class 150 flanged for 2-1/2 inch (65 mm, DN) and larger otherwise threaded.
6. Blowdown Connection: Threaded.
7. Size: Match system flow capacity.
8. Maximum Fluid Service Pressure: 150 psi (1,034 kPa).
9. Maximum Fluid Service Temperature: 250 degrees F (121.1 degrees C).

2.04 HYDRAULIC SEPARATORS (BUFFER TANK)

A. Hydraulic Separator/Buffer Tank:

1. Manufacturers:
 - a. Taco Inc..
 - b. Bell & Gossett.
2. Carbon-steel based, primer-base coated vertical-mounted buffer tank with flanged inlet-outlet pipe connections, and ASME BPVC-VIII-1 tested and stamped for maximum allowed operating pressure of 150 psi (1,034 kPa).
3. Flow Rate Capacity and Pipe Connections: 40 gpm (151.4 Lpm) and 2 inch (50 mm, DN).
4. Threaded Connections: Aquastat, drain, and air vent. Provide aquastat, ball type drain valve, and air vent for field installation.

2.05 DIRT SEPARATORS

A. Manufacturers:

1. Bell & Gossett, a brand of Xylem, Inc; _____: www.bellgossett.com/#sle
 2. Flamco: www.flamcogroup.us/#sle.
- B. Brass combined with high-grade plastics, 3/4 to 2 inch (20 to 50 mm, DN) rotating female threaded connection for use with cold water, hot water, and glycol mixes with maximum working pressure of 145 psi (1,000 kPa) over a temperature range of 14 to 248 degrees F (minus 10 to 120 degrees C).

2.06 STRAINERS

- A. Manufacturers:
1. Grinnell Products; _____: www.grinnell.com/#sle.
 2. Nexus Valve, Inc; _____: www.nexusvalve.com/#sle.
- B. Size 2 inch (50 mm, DN) and Under:
1. Provide threaded, grooved, or sweat brass or iron body for up to 175 psi (1,200 kPa) working pressure, Y-pattern strainer with 1/32 inch (0.8 mm) stainless steel perforated screen.
 2. Body Material by Fluid Service:
 - a. Cast Iron or Brass:
 - 1) Steam: Up to 250 psi at 450 degrees F (1,723.6 kPa at 232.2 degrees C).
 - 2) Liquids: Up to 400 psi at 150 degrees F (2,758 kPa at 65.6 degrees C).
 - b. Stainless Steel:
 - 1) Steam: Up to 600 psi at 486 degrees F (4,136.8 kPa at 252.2 degrees C).
 - 2) Liquids: Up to 1,440 psi at 100 degrees F (9,928.4 kPa at 37.8 degrees C).
- C. Size 2-1/2 inch (65 mm, DN) to 4 inch (100 mm, DN):
1. Provide flanged or grooved iron body for up to 175 psi (1,200 kPa) working pressure, up to 250 degrees F (121.1 degrees C) working temperature, Y-pattern strainer with 1/16 inch (1.6 mm) or 3/64 inch (1.2 mm) stainless steel perforated screen.
 2. Body Material by Fluid Service:
 - a. Cast Iron:
 - 1) Steam: Up to 125 psi at 350 degrees F (861.8 kPa at 51.7 degrees C).
 - 2) Liquids: Up to 200 psi at 150 degrees F (1,379 kPa at 65.6 degrees C).
 - b. Stainless Steel:
 - 1) Liquids: Up to 285 psi at 100 degrees F (1,965 kPa at 37.8 degrees C).
- D. Size 5 inch (125 mm, DN) and Larger:
1. Provide flanged or grooved iron body for up to 175 psi (1200 kPa) working pressure, basket pattern with 1/8 inch (3.2 mm) stainless steel perforated screen.
 2. Liquid Fluid Service: Up to 285 psi at 100 degrees F (1,965 kPa at 37.8 degrees C).
- E. Basket-Type, Size 1 to 30 inch (25 to 750 mm, DN) for Liquid Service:
1. Flanged carbon steel body with 1/8 inch (3.2 mm) stainless steel perforated basket screen, bottom drain and capped air vent.
 2. Fluid Service: Up to 285 psi at 100 degrees F (1,965 kPa at 37.8 degrees C).

2.07 SUCTION DIFFUSERS

- A. Manufacturers:
1. Bell & Gossett, a brand of Xylem, Inc; _____: www.bellgossett.com/#sle.
 2. Grinnell Products; _____: www.grinnell.com/#sle.
- B. Fitting: Angle pattern, cast-iron body, threaded for 2 inch (50 mm) and smaller, flanged for 2-1/2 inch (65 mm, DN) and larger, rated for 175 psi (1200 kPa) working pressure, with inlet vanes, cylinder strainer with 3/16 inch (5 mm) diameter openings, disposable 5/32 inch (4 mm) mesh strainer to fit over cylinder strainer, 20 mesh startup screen, and permanent magnet located in flow stream and removable for cleaning.
- C. Class 125:

1. Horizontally or vertically mounted angle-pattern fitting with integral-cast vanes, fine particle mesh screen and magnetic drain plugs for particle removal without disassembly.
2. Maximum Operating Service: 175 psi (1,200 kPa) and 300 degrees F (148.9 degrees C).
3. Sizes, Material, and Connection:
 - a. 2 inch (50 mm, DN) and Smaller: Cast iron body, threaded.
 - b. 2-1/2 to 12 inch (65 to 300 mm, DN): Ductile iron body, flanged.
- D. Class 150, Size 1-1/2 to 4 inch (40 to 100 mm, DN):
 1. Angle-pattern flanged carbon steel fitted with integral vanes, removable strainer, and magnetic drain plugs for particle removal without disassembly.
 2. Maximum Operating Service:
 - a. Class 150: 150 psi at 450 degrees F (1,034.2 kPa at 232.2 degrees C).

2.08 PUMP CONNECTORS

- A. Flexible Connectors: Flanged, braided type with wetted components of stainless steel, sized to match piping.
 1. Maximum Operating Service: 150 psi (1030 kPa) at 120 degrees F (49 degrees C).
 2. Accommodate the Following:
 - a. Axial Deflection in Compression and Expansion: _____ inch (_____ mm).
 - b. Lateral Movement: _____ inch (_____ mm).
 - c. Angular Rotation: 15 degrees.
 - d. Force developed by 1.5 times specified maximum allowable operating pressure.
 3. End Connections: Same as specified for pipe jointing.
 4. End Connections: Flanged ductile iron; complying with ASME B16.1 Class 125.
 5. End Connections: Threaded; complying with ASME B16.11.
 6. Provide pump connector with integral vanes to reduce turbulent flow.
 7. Provide necessary accessories including, but not limited to, swivel joints.

2.09 PRESSURE-TEMPERATURE TEST PLUGS

- A. Manufacturers:
 1. Peterson Equipment Company Inc; _____: www.petesplug.com/#sle.
 2. Sisco Manufacturing Company Inc; _____: www.siscomfg.com/#sle.
- B. Construction: Brass body designed to receive temperature or pressure probe with removable protective cap, and Neoprene rated for minimum 200 degrees F (93 degrees C).
- C. Application: Use extended length plugs to clear insulated piping.

2.10 BALANCING VALVES

- A. Manufacturers:
 1. Armstrong International, Inc; _____: www.armstronginternational.com/#sle.
 2. Bell & Gossett, a brand of Xylem, Inc; _____: www.bellgossett.com/#sle.
 3. Nexus Valve, Inc; _____: www.nexusvalve.com/#sle.
 4. Taco, Inc; _____: www.taco-hvac.com/#sle.
- B. Size 2 inch (50 mm, DN) and Smaller:
 1. Provide ball or globe style with flow balancing, shut-off capabilities, memory stops, and minimum of two metering ports and female sweat, NPT threaded, press, or soldered connections.
 2. Metal construction materials consist of bronze, brass, or _____.
 3. Non-metal construction materials consist of Teflon, EPDM, engineered resin, or _____.
 4. Maximum Service Operation: 300 psi at 250 degrees F (2,068 kPa at 121.1 degrees C).
- C. Size 2-1/2 inch (65 mm, DN) and Larger:

1. Provide ball, globe, or butterfly style with flow balancing, shut-off capabilities, memory stops, and minimum of two metering ports and flanged, grooved, or weld-end connections.
2. Valve body construction materials consist of cast iron, carbon steel, ductile iron, or _____.
3. Internal components construction materials consist of brass, aluminum bronze, bronze, Teflon, EPDM, NORYL, engineered resin, or _____.
4. Maximum Service Operation: 175 psi at 250 degrees F (1,200 kPa at 121.1 degrees C).

2.11 AUTOMATIC FLOW CONTROL VALVES

- A. Manufacturers:
 1. Bell & Gossett, a brand of Xylem, Inc; _____: www.bellgossett.com/#sle.
 2. Nexus Valve, Inc; _____: www.nexusvalve.com/#sle.
 3. Taco Inc; _____: www.taco-hvac.com/#sle.
- B. Construction:
 1. Brass, bronze, or iron body with union on inlet and outlet, temperature and pressure test plug on inlet and outlet with blowdown/backflush drain.
 2. Built-in lug-type outlet butterfly valve with 2-position handle.
- C. Calibration: Control flow within 10 percent of selected rating, over operating pressure range of 10 times minimum pressure required for control, minimum pressure 2 psi (13.7 kPa).
- D. Control Mechanism: Provide stainless steel or nickel-plated, brass piston or regulator cup, operating against stainless steel helical or wave formed spring or elastomeric diaphragm and polyphenylsulfone orifice plate.
- E. Size: Match system flow capacity.

2.12 FLOW METERS

- A. Manufacturers:
 1. Dwyer Instruments, Inc; _____: www.dwyer-inst.com/#sle.
 2. EMCO Flow Systems; _____: www.emcoflow.com/#sle.
- B. Direct reading with insert pitot tube, threaded coupling, for 150 psi (1034 kPa) working pressure, maximum 240 degrees F (115 degrees C), 5 percent accuracy.
- C. Cast iron, wafer type, orifice insert flow meter for 250 psi (1720 kPa) working pressure, with read-out valves equipped with integral check valves with gasketed caps.
- D. Calibrated, plug type balance valve with precision machined orifice, readout valves equipped with integral check valves and gasketed caps, calibrated nameplate, and indicating pointer.
- E. Cast iron or bronze, globe style, balance valve with handwheel with vernier type ring setting and memory stop, drain connection, readout valves equipped with integral check valves and gasketed caps.
- F. Portable meter consisting of case containing one, 3 percent accuracy pressure gauge with 0-60 feet (0-180 kPa) pressure range for 500 psi (3450 kPa) maximum working pressure, color-coded hoses for low and high-pressure connections, and connectors suitable for connection to read-out valves.
- G. Portable meter consisting of case containing two, 3 percent accuracy pressure gauges with 0-135 inches (0-34 kPa) and 0-60 feet (0-180 kPa) pressure ranges for 500 psi (3450 kPa) maximum working pressure, color coded hoses for low and high pressure connections, and connectors suitable for connection to read-out valves.

2.13 RELIEF VALVES

- A. Manufacturers:
 1. Apollo Valves; _____: www.apollovalves.com/#sle.
 2. Armstrong International, Inc; _____: www.armstronginternational.com/#sle.
 3. Bell & Gossett, a brand of Xylem, Inc; _____: www.bellgossett.com/#sle.

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

2.14 PRESSURE REDUCING VALVES

- A. Manufacturers:
 - 1. Apollo Valves; _____: www.apollovalves.com/#sle.
 - 2. Armstrong International, Inc; _____: www.armstronginternational.com/#sle.
 - 3. Taco, Inc; _____: www.taco-hvac.com/#sle.
- B. Operation: Automatically feeds make-up water to the hydronic system whenever pressure in the system drops below the pressure setting of the valve. Refer to Section 23 21 13.
- C. Materials of Construction:
 - 1. Valve Body: Constructed of bronze, cast iron, brass, iron, or _____.
 - 2. Internal Components: Construct of stainless steel, brass, or _____ and engineered plastics, composition material, or _____.
- D. Connections:
 - 1. NPT threaded: 1/2 inch (15 mm, DN) or 3/4inch (20 mm, DN).
 - 2. Soldered: 1/2 inch (15 mm, DN).
- E. Provide integral check valve and strainer.
- F. Maximum Inlet Pressure: 400 psi (2,758 kPa).
- G. Maximum Fluid Temperature: 180 degrees F (82 degrees C).
- H. Adjustable Pressure Range: From 10 to 45 psi (69 to 310.3 kPa), set to 25 psi (172 kPa).

2.15 PRESSURE INDEPENDENT VALVES

- A. Manufacturers:
 - 1. Griswold Controls LLC; PIC-V: www.griswoldcontrols.com/#sle.
 - 2. Oventrop Corporation; Cocon QTZ: www.ventrop.com/#sle.
- B. Size 2 inch (50 mm, DN) and Smaller:
 - 1. Provide ball, globe, or _____ style with flow balancing, flow measurement, and shut-off capabilities, memory stops, minimum of two metering ports and NPT threaded, soldered, or _____ connections.
 - 2. Metal construction materials consist of bronze, brass, or _____.
 - 3. Non-metal construction materials consist of Teflon, EPDM, engineered resin, or _____.
- C. Size 2-1/2 inch (65 mm, DN) and Larger:
 - 1. Provide ball, globe, butterfly, or _____ style with flow balancing, flow measurement, and shut-off capabilities, memory stops, minimum of two metering ports and flanged, grooved, weld end, or _____ connections.
 - 2. Valve body construction materials consist of cast iron, carbon steel, ductile iron, or _____.
 - 3. Internal components construction materials consist of brass, aluminum bronze, bronze, Teflon, EPDM, NORYL, engineered resin, or _____.

2.16 AUTOMATIC FLOW LIMITING VALVES

- A. Manufacturers:
 - 1. Griswold Controls LLC; Isolator R Valve: www.griswoldcontrols.com/#sle.
 - 2. Hays Fluid Controls; _____: www.haysfluidcontrols.com/#sle.
- B. Size 1/2 inch (15 mm, DN) to 14 inch (350 mm, DN):
 - 1. Provide ball, globe, or _____ style with flow balancing, flow measurement, and shut-off capabilities, memory stops, minimum of two metering ports and NPT threaded, soldered, or _____ connections.

2. Metal construction materials consist of bronze, brass, or _____.
 3. Non-metal construction materials consist of Teflon, EPDM, engineered resin, or _____.
- C. Size 2-1/2 inch (65 mm, DN) to 24 inch (600 mm, DN):
1. Comply with ASME B16.5.
 2. Class: 150.
 3. Provide ball, globe, butterfly, wafer, or _____ style with flow balancing, flow measurement, and shut-off capabilities, memory stops, minimum of two metering ports and flanged, grooved, weld end, or _____ connections.
 4. Valve body construction materials consist of cast iron, carbon steel, ductile iron, gray iron, or _____.
 5. Internal components construction materials consist of brass, aluminum bronze, bronze, Teflon, EPDM, NORYL, engineered resin, or _____.

2.17 GLYCOL SYSTEM

- A. Manufacturers:
1. American Wheatley, a company of Global Flow Products, LLC; _____: www.wheatleyhvac.com/#sle.
 2. Axiom.
- B. Pump System:
1. Storage: 15 gal (56.7 L) polypropylene tank with bolt-removable hinged solid cover and enamel coated carbon steel tank-stand.
 2. Pump:
 - a. Thermally protected 1/4 hp (0.2 kW) motor at 115 to 120 VAC, single phase rated for indoor service.
 - b. Maximum Service Operation: 100 psi (689 kPa) at 85 degrees F (29 degrees C).
 3. Mixer: Tank-stand mounted, removable motorized mixer, prewired and controlled from control panel interface.
 4. Mechanical Accessories: System isolation valves, strainer, and pressure gauges.
 5. Control Panel:
 - a. Fused single-point system connection rated at 115 to 120 VAC, single phase.
 - b. Interface: Hand switches with indicating lights for ON, FAULT, and LOW LEVEL.
 - c. Pressure Switch: Panel-mounted and prewired for 10 psi (69 kPa) cut-in and 40 psi (276 kPa) cut-out, adjustable.
 - d. Low Level Cut-Off Switch: Prewired to shut-down unit upon activation. Tank-side mounted.
 - e. High Level Cut-Off Float Switch: Prewired to shut-down unit upon activation. Tank-side mounted.
 - f. Auxiliary Dry Contacts: Low level, high level, and fault/alarm for remote monitoring.
 - g. Alarm: Audio-visual device with panel-mounted silencing switch to activate upon system fault or alarm with audio pressure level rated for 90 dB.
 6. Pressure Relief Valve: System-mounted brass valve tubed from pump discharge side into tank with adjustable setpoint between 20 psi (138 kPa) and 150 psi (1,034 kPa).
 7. Expansion Tank: Diaphragm type with vent fitting with air separator, and automatic air vent.
- C. Glycol Solution:
1. Water-based solution mix containing 50 percent ethylene glycol by volume required for cooling or heating system operating temperature range.
 2. Cooling or heating System Operating Temperature Range: Between freezing and boiling points of 3 and 220 degees F (minus 16.1 and 104.4 degees C) at 14.7 psia (101.4 kPa).
- D. Mixing Tank: 55 gallon (205 L) steel drum with fittings suitable for filling and hand pump for charging, rubber hose for connection of hand pump to system.

- E. Storage Tank: Closed type, welded-steel construction, tested and stamped in accordance with ASME BPVC-VIII-1; 100 psi (690 kPa) rating; cleaned, prime coated, and supplied with steel support saddles. Construct with tapings for installation of accessories.
- F. Air Pressure Reducing Station: Pressure reducing valve with shut-off valves, strainer, check valve, and needle valve bypass.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install specialties in accordance with manufacturer's instructions.
- B. Where large air quantities can accumulate, provide enlarged air collection standpipes.
- C. Provide manual air vents at system high points and as indicated.
- D. For automatic air vents in ceiling spaces or other concealed locations, provide vent tubing to nearest drain.
- E. Provide air separator on suction side of system circulation pump and connect to expansion tank.
- F. Provide valved drain and hose connection on strainer blowdown connection.
- G. Provide pump suction fitting on suction side of base-mounted centrifugal pumps where indicated. Remove temporary strainers after cleaning systems.
- H. Provide combination pump discharge valve on discharge side of base mounted centrifugal pumps where indicated.
- I. Support pump fittings with floor-mounted pipe and flange supports.
- J. Provide radiator valves on water inlet to terminal heating units such as radiation, unit heaters, and fan coil units.
- K. Provide relief valves on pressure tanks, low-pressure side of reducing valves, heat exchangers, and expansion tanks.
- L. Select system relief valve capacity so that it is greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment.
- M. Pipe relief valve outlet to nearest floor drain.
- N. Where one line vents several relief valves, make cross-sectional area equal to sum of individual vent areas.
- O. Clean and flush glycol system before adding glycol solution, see Section 23 25 00.
- P. Feed glycol solution to system through make-up line with pressure regulator, venting system high points.
- Q. Feed glycol solution to system through make-up line with pressure regulator, venting system high points. Set to fill at 12 psi (80 kPa).
- R. Feed glycol solution to system through make-up line with pressure regulator, venting system high points. Pressure system cold at 5 psi (35 kPa).
- S. Perform tests determining strength of glycol and water solution and submit written test results.

3.02 MAINTENANCE

- A. See Section 01 70 00 - Execution Requirements for additional requirements relating to maintenance service.
- B. Provide a separate maintenance contract for specified maintenance service.
- C. Provide service and maintenance of glycol system for one year from date of Substantial Completion at no extra charge to Owner.

- D. Perform monthly visit to make glycol fluid concentration analysis on site with refractive index measurement instrument. Report findings in detail in writing, including analysis and amounts of glycol or water added.
- E. Explain corrective actions to Owner's maintenance personnel in person.

END OF SECTION

SECTION 23 21 23 HYDRONIC PUMPS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Close-Coupled, In-Line Centrifugal Pumps
- B. Separately-Coupled, Horizontally Mounted, In-Line Centrifugal Pumps.
- C. Automatic Condensate Pump Units.
- D. Electronically Commutated Motors (ECM).

1.02 RELATED REQUIREMENTS

- A. 03 30 00 - Cast-in-Place Concrete
- B. 20 05 29 - Hangers and Supports
- C. 20 05 48 - Vibration and Seismic Controls
- D. 20 05 13 - Common Mechanical Motor Requirements
- E. 26 05 19 - Low-Voltage Electrical Power Conductors and Cables
- F. 26 05 23 - Control-Voltage Electrical Power Cables
- G. 26 05 26 - Grounding and Bonding for Electrical Systems

1.03 REFERENCE STANDARDS

- A. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures; Most Recent Edition Cited by Referring Code or Reference Standard.
- B. ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications; 2022.
- C. CSA B139 - Installation Code for Oil-burning Equipment; x.
- D. HI 1.1 - Rotodynamic Centrifugal Pumps For Nomenclature And Definitions; 2014.
- E. HI 1.2 - Rotodynamic Centrifugal Pumps For Nomenclature And Definitions; 2014.
- F. HI 1.3 - Rotodynamic Centrifugal Pumps For Design And Application; 2013.
- G. HI 1.4 - Rotodynamic Centrifugal Pumps For Manuals Describing Installation, Operation, And Maintenance; 2014.
- H. HI 2.1 - Rotodynamic Vertical Pumps Or Radial, Mixed, And Axial Flow Types For Nomenclature And Definitions; 2014.
- I. HI 2.4 - Rotodynamic (Vertical) Pumps For Manuals Describing Installation, Operation, And Maintenance; 2014.
- J. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.
- K. NEMA MG 00001 - Motors and Generators; 2024.
- L. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Delegated Design: Engage a qualified professional engineer, as defined in Division 01 to design vibration isolation and seismic restraints.
 - 1. Seismic Performance: Pumps shall withstand the effects of earthquake motions determined in accordance with ASCE 7.
 - a. The term "withstand" means:

- 1) The unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified
 - 2) The unit will be fully operational after the seismic event.
- b. Component Importance Factor: 1.0.

1.05 SUBMITTALS

A. Action Submittals

1. Product Data: Provide certified pump curves showing performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Include electrical characteristics and connection requirements.
2. Millwright's Certificate: Certify that base mounted pumps have been aligned.
3. Manufacturer's Installation Instructions: Indicate hanging and support requirements and recommendations.
4. Start Up Service: Include documentation from required start up service.
5. Testing: Include documentation from required tests and inspections.
 - a. The product is a 'Major' piece of equipment
 - b. The product contains refrigerant
 - c. The cost of a group of products serving a given function constitutes 5% or greater of the sub-contractor's budget, excluding labor.
6. Embodied Carbon Submittals
 - a. Order of Preferred Submittals: For products which require an embodied carbon submittal (described above), one of the following must be provided. The submittal must be that with the highest preference available. The order preference, from highest to lowest is:
 - 1) Product Specific, Facility Specific EPD
 - 2) Product Specific EPD
 - 3) Industry Average EPD

B. Operation and Maintenance Materials

1. Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

1.06 PRE-INSTALLATION TESTING

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections with the assistance of a factory-authorized service representative.
- C. Hydronic pumps will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

1.07 EXTRA MATERIALS

- A. Extra Pump Seals: One set for each type and size of pump.
- B. Extra Cartridges for Side-Stream Filters: One set for each filter.

PART 2 PRODUCTS

2.01 GENERAL

- A. Manufacturers:
 1. Armstrong Pumps.
 2. Aurora Pump.
 3. Bell & Gossett.
 4. Burks Pumps.
 5. Crane Pumps & Systems.
 6. Deming.
 7. Flowserve Corporation.

8. Grundfos Pumps Corporation.
 9. ITT Corporation.
 10. Little Giant Pump Co.
 11. Mepco.
 12. Paco Pumps.
 13. Patterson Pump Company.
 14. Peerless Pump Company.
 15. Taco.
 16. Thrush Company.
 17. Weinman.
- B. Source Limitations: Obtain pumps from single source from single manufacturer.
- C. Ratings: Rate pump for 250-psig (1720-kPa) minimum working pressure and 200 deg F (93 deg C) continuous water temperature, unless indicated otherwise below or on drawings.
- D. Motors:
1. Enclosures: Totally enclosed, fan cooled. Unless indicated otherwise below or on drawings.
 2. Premium Efficient motors as defined in NEMA MG 00001.
 3. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
- E. Pump Requirements
1. Pump Units: Proposed change here.
 2. Any pump supplied that is regulated by the Department of Energy pump standards shall be tested using the PERCL method. The pump nameplate shall bear the PERCL index. Pumps bearing only the PERVL index will not be accepted. Submittals shall clearly identify the PEI's index and affirm that the index meets the DOE pump standards.
- F. Selection Criteria:
1. Base non-overloading characteristics for pumps upon nameplate horsepower, at any point on performance curve.
 2. Pump speed shall be limited to 1,800 RPM except as scheduled.
 3. Shaft first critical speed shall not be less than 25 percent greater than operating speed.
 4. Maximum impeller diameter shall not be greater than 90 percent of "cut water" diameter for a given casing and no smaller than the smallest published diameter for casing. Do not base acceptable maximum diameter calculation on percentage of impeller diameter range for a given casing.
 5. Select at the point of maximum efficiency for a given impeller-casing combination. Deviations shall be within 3 percent of maximum efficiency on the increasing capacity side of the maximum efficiency point and 7 percent on the decreasing capacity side of the maximum efficiency point.
 6. Select pump at a point no greater than 85 percent of end of curve flow.
 7. Maximum pump suction velocity:
 - a. In-line: 12 fps.
 - b. End suction: 13 fps.
 - c. Double suction: 15 fps.
- G. All chilled water and hot water loops shall be fitted with side filters for cleaning of loop water.
- H. Check valves shall be used on pump discharge in lieu of automated isolation valve.

2.02 CLOSE-COUPLED, IN-LINE CENTRIFUGAL PUMPS

- A. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, in-line pump as defined in HI 1.1-HI 1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally or vertically.

- B. Ratings: Rate pump for 250-psig (1720-kPa) minimum working pressure and 250 deg F (121 deg C) continuous water temperature.
- C. Pump Construction:
 - 1. Casing: Radially split, cast iron, with replaceable bronze wear rings, drain plug at bottom and air vent at top of volute, threaded gauge tapings at inlet and outlet, and flanged connections.
 - 2. Impeller: ASTM B584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For constant-speed pumps, trim impeller to match specified performance.
 - 3. Pump Shaft Sleeve: Bronze.
 - 4. Pump Stub Shaft: Bronze.
 - 5. Seal: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless steel spring, and NBR bellows and gasket. Include water slinger on shaft between motor and seal.
 - 6. Texas Mechanical Specific Requirement.
- D. Motor:
 - 1. Enclosure: Totally enclosed, fan cooled. Unless indicated otherwise on drawings.

2.03 SEPARATELY-COUPLED, HORIZONTALLY MOUNTED, IN-LINE CENTRIFUGAL PUMPS

- A. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, in-line pump as defined in HI 1.1-HI 1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally. Rate pump for 175-psig (1204-kPa) minimum working pressure and a continuous water temperature of 250 deg F (121 deg C).
- B. Pump Construction:
 - 1. Casing: Radially split, cast iron, with threaded gage tapings at inlet and outlet, and threaded companion-flange connections.
 - 2. Impeller: ASTM B584, cast bronze; statically and dynamically balanced, and keyed to shaft. For pumps not frequency-drive controlled, trim impeller to match specified performance.
 - 3. Pump Shaft: Carbon steel, with copper-alloy shaft sleeve.
 - 4. Seal: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless steel spring, and NBR bellows and gasket.
 - 5. Pump Bearings: Permanently lubricated ball bearings.
- C. Shaft Coupling: Molded-rubber insert with interlocking spider capable of absorbing vibration.
- D. Motor: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Division 20 Section 20 05 13 - Common Mechanical Motor Requirements.
 - 1. Enclosure Type: Totally enclosed, fan cooled.
 - 2. NEMA Premium Efficient motors as defined in NEMA MG 00001.
 - 3. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 - 4. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
 - 5. Single-speed motor.
 - 6. Provide integral pump motor variable-speed controller.

2.04 AUTOMATIC CONDENSATE PUMP UNITS

- A. Description: Packaged units with corrosion-resistant pump, aluminum tank with cover, and automatic controls. Collects and removes condensate from fan coil units, air handling units, condensing boilers, and similar components. Include factory- or field-installed check valve and a 72-inch- (1800-mm-) minimum, electrical power cord with plug.

2.05 PUMP SPECIALTIES AND FITTINGS

- A. Triple-Duty Valves:
 - 1. Angle or straight pattern.
 - 2. 175-psig (1204-kPa) pressure rating, cast-iron body, pump-discharge fitting.
 - 3. Valve with multi-turn stem and memory stop to allow valve to be returned to its original position after shutoff.
 - 4. Brass valve disc with EPDM rubber seat.
 - 5. Type 304 stainless steel valve stem.
 - 6. Drain plug and bronze-fitted shutoff, balancing, and check valve features.
 - 7. Brass gauge ports with integral check valve and orifice for flow measurement.
- B. Integral Pump Motor Variable-Speed Controllers
 - 1. Where specified or scheduled, provide pumps with an integral pump motor speed controller.
 - a. Motor: Operates as constant- or variable-speed pump with speed regulated by an integrated variable-speed drive.
 - b. Integrated Pump Controller: Supports direct communication with the building management system (BMS) with built-in support for the following protocols: Modbus RTU.
 - c. Commissioning and pump set up access to pump controls via the following:
 - 1) A web interface (data exchange).
 - 2) A user interface located on the face of speed controller to adjust modes and mode values.
 - 3) An electronic display that reads real-time mode set values, flow, head, speed, and power and that locks out unauthorized adjustment of pump.
 - d. Provide electronics with "Auto" as factory default but slope of the proportional curve will automatically match the required system curve, constant pressure control (delta-p/c), variable differential pressure control (delta-p/v), constant curve duty (uncontrolled pump), and rpm regulation. RPM (speed) regulation can be accomplished by the following:
 - 1) Manual (via user interface or HTML).
 - 2) Remote via 0 to 10 V dc.
 - 3) Data protocol communications with the BMS.
 - e. Pump Electronics: Standard with multiple digital inputs and one external digital output to be available for additional mechanical room control and pump status monitoring.
 - f. Controller: Mounted on or adjacent to the motor. Provide enclosure rated to UL Type 12.
 - g. Electronically Protected Pumps: Rated for continuous duty and with built-in startup circuit. Provide overcurrent, line surge and current limit protection, thermal monitoring, heat sink status and over temperature protection.
 - h. Pump capable of being monitored continuously via integrated Internet link.
 - i. Integrated pump controller system to have the following features:
 - 1) Controller software shall be capable of sensorless control in variable-volume systems without need for pump-mounted (internal/external) or remotely mounted differential pressure sensor.
 - 2) Integrated Pump Controller Sensorless Control: Operates under Quadratic Pressure Control (QPC) to ensure that head reduction with reducing flow conforms to quadratic control curve.
 - 3) Controller:
 - (a) Minimum head of 40 percent of design duty head.
 - (b) User-adjustable control mode settings and minimum/maximum head set points using built-in programming interface.
 - 4) Controller Integrated Control Software:

- (a) Capable of controlling pump performance for non-overloading power at every point of operation.
- (b) Capable of maintaining flow rate data.

2.06 ELECTRONICALLY COMMUTATED MOTORS (ECM)

- A. Provide pumps so they are specified or scheduled with ECM.
 - 1. Synchronous, constant torque, ECM with permanent magnet rotor. Rotor magnets to be time-stable, nontoxic ceramic magnets (Sr-Fe).
 - 2. Driven by a frequency converter with an integrated power factor correction filter. Conventional induction motors will not be acceptable.
 - 3. Each motor with an integrated variable-frequency drive, tested as one unit by manufacturer.
 - 4. Motor speed adjustable over full range from 0 rpm to maximum scheduled speed.
 - 5. Variable motor speed to be controlled by a 0- to 10 V-dc or 4- to 20-mA input.
 - 6. Integrated motor protection verified by UL to protect the pump against over-/undervoltage, overtemperature of motor and/or electronics, overcurrent, locked rotor, and dry run (no-load condition).

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of work.
- B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.
- C. Examine foundations and inertia bases for suitable conditions where pumps are to be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 START UP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Check piping connections for tightness.
 - 3. Clean strainers on suction piping. Use startup strainer for initial startup.
 - 4. Perform the following startup checks for each pump before starting:
 - a. Verify bearing lubrication.
 - b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
 - c. Verify that pump is rotating in the correct direction.
 - 5. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
 - 6. Start motor.
 - 7. Open discharge valve slowly.
 - 8. Remove suction diffuser startup strainers after 48 hours of continuous circulation.

3.03 DEMONSTRATION AND TRAINING

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps.

3.04 ALIGNMENT

- A. Engage a factory-authorized service representative to perform alignment service.
- B. Perform alignment service. When required by manufacturer to maintain warranty coverage, engage a factory-authorized service representative to perform it.

- C. Comply with requirements in HI standards for alignment of pump and motor shaft. Add shims to the motor feet and bolt motor to base frame. Do not use grout between motor feet and base frame.
- D. Comply with pump and coupling manufacturers' written instructions.
- E. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

END OF SECTION

**SECTION 23 23 00
REFRIGERANT PIPING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Copper Tube and Fittings.
- B. Copper Tube and Fittings (VRF and Small Systems)
- C. Steel Pipe and Fittings.
- D. Valves and Specialties.
 - 1. Diaphragm Packless Valves.
 - 2. Packed-Angle Valves.
 - 3. Check Valves.
 - 4. Service Valves.
 - 5. Solenoid Valves.
 - 6. Safety Relief Valves.
 - 7. Thermostatic Expansion Valves.
 - 8. Hot-Gas Bypass Valves.
 - 9. Straight-Type Strainers.
 - 10. Angle-Type Strainers.
 - 11. Moisture/Liquid Indicators.
 - 12. Replaceable-Core Filter Dryers.
 - 13. Permanent Filter Dryers.
 - 14. Mufflers.
 - 15. Receivers.
 - 16. Liquid Accumulators.
- E. Refrigerants.

1.02 REFERENCE STANDARDS

- A. ARI 495 - x; x.
- B. ARI 730 - Flow-Capacity Rating and Application of Suction-Line Filters and Filter Dryers; Latest Edition.
- C. ARI 750 - Thermostatic Refrigerant Expansion Valve; Latest Edition.
- D. ARI 760 - Solenoid Valves for Use with Volatile Refrigerants; Latest Edition.
- E. ASHRAE Std 15 - Safety Standard for Refrigeration Systems; 2024, with Errata (2025).
- F. ASHRAE Std 34 - Designation and Safety Classification of Refrigerants; 2024, with Addendum (2025).
- G. ASME B1.20.1 - Pipe Threads, General Purpose, Inch; 2013 (Reaffirmed 2018).
- H. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24 Metric/Inch Standard; 2025.
- I. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators; 2025, with Errata.
- J. {RSTEMP#367}ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; The American Society of Mechanical Engineers{CH#85878}.
- K. ASME B31.5 - Refrigeration Piping and Heat Transfer Components; 2022.
- L. {RSTEMP#396}

- M. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2025.
- N. ASTM B32 - Standard Specification for Solder Metal; 2020.
- O. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2022.
- P. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric); 2020.
- Q. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Services; 2022.
- R. ASTM B828 - Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings; 2023.
- S. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding; 2019.
- T. AWS D10.12/D10.12M - GUIDE FOR WELDING MILD STEEL PIPE; 2000.
- U. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2018, with Amendment (2019).
- V. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.
- W. UL 207 - Standard for Refrigerant-Containing Components and Accessories, Nonelectrical; Current Edition, Including All Revisions.
- X. {RSTEMP#2109}UL 429 - Electrically Operated Valves; Underwriters Laboratories Inc.{CH#85919}.

1.03 PERFORMANCE REQUIREMENTS

- A. Line Test Pressure for Refrigerant R-134a:
 - 1. Suction Lines for Air-Conditioning Applications: 115 psig (793 kPa).
 - 2. Suction Lines for Heat-Pump Applications: 225 psig (1551 kPa).
 - 3. Hot-Gas and Liquid Lines: 225 psig (1551 kPa).
- B. Line Test Pressure for Refrigerant R-407C:
 - 1. Suction Lines for Air-Conditioning Applications: 230 psig (1586 kPa).
 - 2. Suction Lines for Heat-Pump Applications: 380 psig (2620 kPa).
 - 3. Hot-Gas and Liquid Lines: 380 psig (2620 kPa).
- C. Line Test Pressure for Refrigerant R-410A:
 - 1. Suction Lines for Air-Conditioning Applications: 300 psig (2068 kPa).
 - 2. Suction Lines for Heat-Pump Applications: 535 psig (3689 kPa).
 - 3. Hot-Gas and Liquid Lines: 535 psig (3689 kPa).

1.04 SUBMITTALS

- A. Action Submittals
 - 1. Product Data: Provide general assembly of specialties, including manufacturer's catalogue information. Provide manufacturer's catalog data including load capacity.
 - 2. Shop Drawings: Indicate schematic layout of system, including equipment, critical dimensions, and sizes.
 - 3. Design Data: Submit design data indicating pipe sizing. Indicate load-carrying capacity of trapeze, multiple pipe, and riser support hangers.
 - 4. Manufacturer's Installation Instructions: Indicate support, connection requirements, and isolation for servicing.
 - 5. Test Reports: Indicate results of leak test, acid test.
 - 6. Submit welders certification of compliance with ASME BPVC-IX.
 - 7. Designer's qualification statement.
 - 8. Installer's qualification statement.
- B. Operation and Maintenance Materials

1. Include instructions for changing cartridges, assembly views, spare parts lists.
- C. Record Documents
 1. Record exact locations of equipment and refrigeration accessories on record drawings.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Deliver and store piping and specialties in shipping containers with labeling in place.
- B. Protect piping and specialties from entry of contaminating material by leaving end caps and plugs in place until installation.
- C. Dehydrate and charge components such as piping and receivers, seal prior to shipment, until connected into system.

1.06 EXTRA MATERIALS

PART 2 PRODUCTS

2.01 COPPER TUBE AND FITTINGS

- A. Copper Tube: ASTM B88 , Type K or L (ASTM B88M , Type A or B).
- B. Wrought-Copper Fittings: {RS#367}.
- C. Wrought-Copper Unions: {RS#367}.
- D. Solder Filler Metals: ASTM B32 Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.
- E. Brazing Filler Metals: AWS A5.8M/A5.8.
- F. Flexible Connectors:
 1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
 2. End Connections: Socket ends.
 3. Offset Performance: Capable of minimum 3/4-inch (20-mm) misalignment in minimum 7-inch- (180-mm-) long assembly.
 4. Pressure Rating: Factory test at minimum 500 psig (3450 kPa).
 5. Maximum Operating Temperature: 250 deg F (121 deg C).

2.02 COPPER TUBE AND FITTINGS (VRF AND SMALL SYSTEMS)

- A. Copper Tube: Type ACR, annealed-temper tube, clean, dry and capped.
 1. Fittings: {RS#367} wrought copper.
 2. Joints: Braze, AWS A5.8M/A5.8 BCuP silver/phosphorus/copper alloy (15 percent Silver).
- B. Packaged Ball Valves: Two piece bolted forged brass body with Teflon ball seals and copper tube extensions, brass seal cap, chrome plated ball, stem with neoprene ring stem seals; for maximum working pressure of and maximum temperature of 300 degrees F.
- C. Flexible Connectors: Provide stainless steel refrigerant flexible connector with copper ends, operating at 700 psi, cleaned and bagged per PRAXAIR 99.

2.03 STEEL PIPE AND FITTINGS

- A. Wrought-Steel Fittings: ASTM A234/A234M, for welded joints.
- B. Steel Flanges and Flanged Fittings: ASME B16.5, steel, including bolts, nuts, and gaskets, bevel-welded end connection, and raised face.
 1. Piston: Removable Polytetrafluoroethylene seat.
- C. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- D. Flanged Unions:
 1. Body: Forged-steel flanges for NPS 1 to NPS 1-1/2 (DN 25 to DN 40) and ductile iron for NPS 2 to NPS 3 (DN 50 to DN 80). Apply rust-resistant finish at factory.

2. Gasket: Fiber asbestos free.
 3. Fasteners: Four plated-steel bolts, with silicon bronze nuts. Apply rust-resistant finish at factory.
 4. End Connections: Brass tailpiece adapters for solder-end connections to copper tubing.
 5. Offset Performance: Capable of minimum 3/4-inch (20-mm) misalignment in minimum 7-inch- (180-mm-) long assembly.
 6. Pressure Rating: Factory test at minimum 400 psig (2760 kPa).
 7. Maximum Operating Temperature: 330 deg F (165 deg C).
- E. Flexible Connectors:
1. Body: Stainless-steel bellows with woven, flexible, stainless-steel-wire-reinforced protective jacket
 2. End Connections:
 - a. NPS 2 (DN 50) and Smaller: With threaded-end connections.
 - b. NPS 2-1/2 (DN 65) and Larger: With flanged-end connections.
 3. Offset Performance: Capable of minimum 3/4-inch (20-mm) misalignment in minimum 7-inch- (180-mm-) long assembly.
 4. Pressure Rating: Factory test at minimum 500 psig (3450 kPa).
 5. Maximum Operating Temperature: 250 deg F (121 deg C).

2.04 VALVES AND SPECIALTIES

- A. Diaphragm Packless Valves:
1. Manufacturers:
 - a. Danfoss.
 - b. Heldon Products.
 - c. Parker Hannifin Corp.
 - d. Paul Mueller Company.
 2. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
 3. Diaphragm: Phosphor bronze and stainless steel with stainless-steel spring.
 4. Operator: Rising stem and hand wheel.
 5. Seat: Nylon.
 6. End Connections: Socket, union, or flanged.
 7. Working Pressure Rating: 500 psig (3450 kPa).
 8. Maximum Operating Temperature: 275 deg F (135 deg C).
- B. Packed-Angle Valves:
1. Manufacturers:
 - a. Danfoss.
 - b. Heldon Products.
 - c. Parker Hannifin Corp.
 - d. Paul Mueller Company.
 2. Body and Bonnet: Forged brass or cast bronze.
 3. Packing: Molded stem, back seating, and replaceable under pressure.
 4. Operator: Rising stem.
 5. Seat: Nonrotating, self-aligning Polytetrafluoroethylene.
 6. Seal Cap: Forged-brass or valox hex cap.
 7. End Connections: Socket, union, threaded, or flanged.
 8. Working Pressure Rating: 500 psig (3450 kPa).
 9. Maximum Operating Temperature: 275 deg F (135 deg C).
- C. Check Valves:
1. Manufacturers:
 - a. Danfoss.

- b. Emerson Climate Technologies.
 - c. Heldon Products.
 - d. Parker Hannifin Corp.
 - e. Paul Mueller Company.
 - 2. Body: Ductile iron, forged brass, or cast bronze; globe pattern.
 - 3. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
 - 4. Piston: Removable Polytetrafluoroethylene seat.
 - 5. Closing Spring: Stainless steel.
 - 6. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.
 - 7. End Connections: Socket, union, threaded, or flanged.
 - 8. Maximum Opening Pressure: 0.50 psig (3.4 kPa) .
 - 9. Working Pressure Rating: 500 psig (3450 kPa).
 - 10. Maximum Operating Temperature: 275 deg F (135 deg C).
- D. Service Valves:
- 1. Manufacturers:
 - a. Danfoss.
 - b. Emerson Climate Technologies.
 - c. Heldon Products.
 - d. Parker Hannifin Corp.
 - e. Paul Mueller Company.
 - f. Refrigeration Sales.
 - 2. Body: Forged brass with brass cap including key end to remove core.
 - 3. Core: Removable ball-type check valve with stainless-steel spring.
 - 4. Seat: Polytetrafluoroethylene.
 - 5. End Connections: Copper spring.
 - 6. Working Pressure Rating: 500 psig (3450 kPa).
- E. Solenoid Valves: Comply with ARI 760 and {RS#2109}; listed and labeled by an NRTL.
- 1. Manufacturers:
 - a. Danfoss.
 - b. Emerson Climate Technologies.
 - c. Heldon Products.
 - d. Parker Hannifin Corp.
 - e. Paul Mueller Company.
 - 2. Body and Bonnet: Plated steel.
 - 3. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
 - 4. Seat: Polytetrafluoroethylene.
 - 5. End Connections: Threaded.
 - 6. Electrical: Molded, watertight coil in NEMA EN 10250 enclosure of type required by location with 1/2-inch (16-GRC) conduit adapter, and 24-V ac coil.
 - 7. Working Pressure Rating: 400 psig (2760 kPa).
 - 8. Maximum Operating Temperature: 240 deg F (116 deg C).
 - 9. Manual operator.
- F. Safety Relief Valves: Comply with {RS#396}; listed and labeled by an NRTL.
- 1. Manufacturers:
 - a. Danfoss.
 - b. Heldon Products.
 - c. Parker Hannifin Corp.
 - d. Paul Mueller Company.
 - 2. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
 - 3. Piston, Closing Spring, and Seat Insert: Stainless steel.

4. Seat Disc: Polytetrafluoroethylene.
5. End Connections: Threaded.
6. Working Pressure Rating: 400 psig (2760 kPa).
7. Maximum Operating Temperature: 240 deg F (116 deg C).
- G. Thermostatic Expansion Valves: Comply with ARI 750.
 1. Manufacturers:
 - a. Danfoss.
 - b. Emerson Climate Technologies.
 - c. Heldon Products.
 - d. Paul Mueller Company.
 2. Body, Bonnet, and Seal Cap: Forged brass or steel.
 3. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
 4. Packing and Gaskets: Non-asbestos.
 5. Capillary and Bulb: Copper tubing filled with refrigerant charge.
 6. Suction Temperature: 40 deg F (4.4 deg C).
 7. Superheat: Adjustable.
 8. Reverse-flow option (for heat-pump applications).
 9. End Connections: Socket, flare, or threaded union.
 10. Working Pressure Rating: 700 psig (4820 kPa).
- H. Hot-Gas Bypass Valves: Comply with {RS#2109}; listed and labeled by an NRTL.
 1. Manufacturers:
 - a. Danfoss.
 - b. Heldon Products.
 - c. Parker Hannifin Corp.
 2. Body, Bonnet, and Seal Cap: Ductile iron or steel.
 3. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
 4. Packing and Gaskets: Non-asbestos.
 5. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
 6. Seat: Polytetrafluoroethylene.
 7. Equalizer: Internal.
 8. Electrical: Molded, watertight coil in NEMA EN 10250 enclosure of type required by location with 1/2-inch (16-GRC) conduit adapter, and 24-V ac coil.
 9. End Connections: Socket.
 10. Set Pressure:
 11. Throttling Range: Maximum 5 psig (34 kPa).
 12. Working Pressure Rating: 500 psig (3450 kPa).
 13. Maximum Operating Temperature: 240 deg F (116 deg C).
- I. Straight-Type Strainers:
 1. Manufacturers:
 - a. Danfoss.
 - b. Heldon Products.
 - c. Parker Hannifin Corp.
 2. Body: Welded steel with corrosion-resistant coating.
 3. Screen: 100-mesh stainless steel.
 4. End Connections: Socket or flare.
 5. Working Pressure Rating: 500 psig (3450 kPa).
 6. Maximum Operating Temperature: 275 deg F (135 deg C).
- J. Angle-Type Strainers:
 1. Manufacturers:
 - a. Danfoss.

- b. Heldon Products.
 - c. Parker Hannifin Corp.
 - 2. Body: Forged brass or cast bronze.
 - 3. Drain Plug: Brass hex plug.
 - 4. Screen: 100-mesh Monel.
 - 5. End Connections: Socket or flare.
 - 6. Working Pressure Rating: 500 psig (3450 kPa).
 - 7. Maximum Operating Temperature: 275 deg F (135 deg C).
- K. Moisture/Liquid Indicators:
 - 1. Manufacturers:
 - a. Danfoss.
 - b. Emerson Climate Technologies.
 - c. Heldon Products.
 - d. Parker Hannifin Corp.
 - 2. Body: Forged brass.
 - 3. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
 - 4. Indicator: Color coded to show moisture content in ppm.
 - 5. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
 - 6. End Connections: Socket or flare.
 - 7. Working Pressure Rating: 500 psig (3450 kPa).
 - 8. Maximum Operating Temperature: 240 deg F (116 deg C).
- L. Replaceable-Core Filter Dryers: Comply with ARI 730.
 - 1. Manufacturers:
 - a. Danfoss.
 - b. Emerson Climate Technologies.
 - c. Heldon Products.
 - d. Parker Hannifin Corp.
 - 2. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
 - 3. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
 - 4. Desiccant Media: Activated alumina.
 - 5. Designed for reverse flow (for heat-pump applications).
 - 6. End Connections: Socket.
 - 7. Access Ports: NPS 1/4 (DN 8) connections at entering and leaving sides for pressure differential measurement.
 - 8. Maximum Pressure Loss: 2 psig (14 kPa).
 - 9. Rated Flow:
 - 10. Working Pressure Rating: 500 psig (3450 kPa).
 - 11. Maximum Operating Temperature: 240 deg F (116 deg C).
- M. Permanent Filter Dryers: Comply with ARI 730.
 - 1. Manufacturers:
 - a. Danfoss.
 - b. Emerson Climate Technologies.
 - c. Heldon Products.
 - d. Parker Hannifin Corp.
 - 2. Body and Cover: Painted-steel shell.
 - 3. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
 - 4. Desiccant Media: Activated alumina.
 - 5. Designed for reverse flow (for heat-pump applications).
 - 6. End Connections: Socket.

7. Access Ports: NPS 1/4 (DN 8) connections at entering and leaving sides for pressure differential measurement.
 8. Maximum Pressure Loss: 2 psig (14 kPa).
 9. Rated Flow:
 10. Working Pressure Rating: 500 psig (3450 kPa).
 11. Maximum Operating Temperature: 240 deg F (116 deg C).
- N. Mufflers:
1. Manufacturers:
 - a. Danfoss.
 - b. Emerson Climate Technologies.
 - c. Heldon Products.
 2. End Connections: Socket or flare.
 3. Working Pressure Rating: 500 psig (3450 kPa).
 4. Maximum Operating Temperature: 275 deg F (135 deg C).
- O. Receivers: Comply with ARI 495.
1. Manufacturers:
 - a. Heldon Products.
 2. Comply with {RS#396}; listed and labeled by an NRTL.
 3. Comply with UL 207; listed and labeled by an NRTL.
 4. Body: Welded steel with corrosion-resistant coating.
 5. Tappings: Inlet, outlet, liquid level indicator, and safety relief valve.
 6. End Connections: Socket or threaded.
 7. Working Pressure Rating: 500 psig (3450 kPa).
 8. Maximum Operating Temperature: 275 deg F (135 deg C).
- P. Liquid Accumulators: Comply with ARI 495.
1. Manufacturers:
 - a. Emerson Climate Technologies.
 - b. Heldon Products.
 - c. Parker Hannifin Corp.
 2. Body: Welded steel with corrosion-resistant coating.
 3. End Connections: Socket or threaded.
 4. Working Pressure Rating: 500 psig (3450 kPa).
 5. Maximum Operating Temperature: 275 deg F (135 deg C).

2.05 REFRIGERANTS

- A. Manufacturers:
1. Arkema.
 2. DuPont Fluorochemicals Div.
 3. Genetron Refrigerants.
 4. Mexichem Fluor.
- B. ASHRAE Std 34, R-454B

PART 3 EXECUTION

3.01 APPLICATION

- A. Piping Applications for Refrigerant R-134A
1. Suction Lines NPS 1-1/2 (DN 40) and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.
 2. Suction Lines NPS 4 (DN 100) and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with brazed joints.

3. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.
 4. Hot-Gas and Liquid Lines , and Suction Lines for Heat-Pump Applications: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with soldered joints.
 5. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications:
 - a. NPS 1-1/2 (DN 40) and Smaller : Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.
 - b. NPS 1-1/2 (DN 40) and Smaller : Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with brazed joints.
 - c. NPS 4 (DN 100) : Copper, Type ACR , drawn-temper tubing and wrought-copper fittings with brazed joints.
 6. Safety-Relief-Valve Discharge Piping: Schedule 40, black-steel and wrought-steel fittings with welded joints.
 7. Safety-Relief-Valve Discharge Piping: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with soldered joints.
 8. Safety-Relief-Valve Discharge Piping:
 - a. NPS 1-1/2 (DN 40) and Smaller : Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.
 - b. NPS 1-1/2 (DN 40) and Smaller : Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with brazed joints.
 - c. NPS 4 (DN 100) : Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with brazed joints.
- B. Piping Applications for Refrigerant R-407C
1. Suction Lines NPS 1-1/2 (DN 40) and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.
 2. Suction Lines NPS 4 (DN 100) and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with brazed joints.
 3. Hot-Gas and Liquid Lines , and Suction Lines for Heat-Pump Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.
 4. Hot-Gas and Liquid Lines , and Suction Lines for Heat-Pump Applications: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with soldered joints.
 5. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications:
 - a. NPS 1 (DN 25) and Smaller: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with brazed joints.
 - b. NPS 1-1/4 to NPS 2 (DN 32 to DN 50): Copper, Type K (A), annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.
 - c. NPS 4 (DN 100): Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with soldered joints.
 6. Safety-Relief-Valve Discharge Piping: Schedule 40, black-steel and wrought-steel fittings with welded joints.
 7. Safety-Relief-Valve Discharge Piping: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with soldered joints.
 8. Safety-Relief-Valve Discharge Piping:
 - a. NPS 1 (DN 25) and Smaller: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.
 - b. NPS 1 (DN 25) and Smaller: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with brazed joints.
 - c. NPS 1-1/4 to NPS 2 (DN 32 to DN 50 : Copper, Type K (A), annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.

- d. NPS 4 (DN 100) : Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with soldered joints.
 - 9. Suction Lines NPS 1-1/2 (DN 40) and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.
 - 10. Suction Lines NPS 3-1/2 (DN 90) and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with brazed joints.
 - 11. Suction Lines NPS 4 (DN 100) and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with soldered joints.
 - 12. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications : Copper, Type ACR, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.
 - 13. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: Copper, Type K (A), annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.
 - 14. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with 95-5 tin-antimony soldered joints.
 - 15. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with Alloy HB soldered joints.
 - 16. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications:
 - a. NPS 5/8 (DN 18) and Smaller : Copper, Type ACR, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.
 - b. NPS 3/4 to NPS 1 (DN 20 to DN 25) and Smaller : Copper, Type K (A), annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.
 - c. NPS 1-1/4 (DN 32) and Smaller : Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with 95-5 tin-antimony soldered joints.
 - d. NPS 1-1/2 to NPS 2 (DN 40 to DN 50) : Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with Alloy HB soldered joints.
 - 17. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: Schedule 40, black-steel and wrought-steel fittings with welded joints.
 - 18. Safety-Relief-Valve Discharge Piping: Copper, Type ACR, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.
 - 19. Safety-Relief-Valve Discharge Piping: Copper, Type K (A), annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.
 - 20. Safety-Relief-Valve Discharge Piping: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with 95-5 tin-antimony soldered joints.
 - 21. Safety-Relief-Valve Discharge Piping: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with Alloy HB soldered joints.
 - 22. Safety-Relief-Valve Discharge Piping:
 - a. NPS 5/8 (DN 18) and Smaller : Copper, Type ACR, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.
 - b. NPS 3/4 to NPS 1 (DN 20 to DN 25) and Smaller: Copper, Type K (A), annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.
 - c. NPS 1-1/4 (DN 32) and Smaller : Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with 95-5 tin-antimony soldered joints.
 - d. NPS 1-1/2 to NPS 2 (DN 40 to DN 50): Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with Alloy HB soldered joints.
 - 23. Safety-Relief-Valve Discharge Piping NPS 2 to NPS 4 (DN 50 to DN 100): Schedule 40, black-steel and wrought-steel fittings with welded joints.
- C. Valve and Specialty Applications
- 1. Install diaphragm packless valves in suction and discharge lines of compressor.

2. Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.
3. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.
4. Except as otherwise indicated, install diaphragm packless valves on inlet and outlet side of filter dryers.
5. Install a full-sized, three-valve bypass around filter dryers.
6. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.
7. Install thermostatic expansion valves as close as possible to distributors on evaporators.
 - a. Install valve so diaphragm case is warmer than bulb.
 - b. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
 - c. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.
8. Install safety relief valves where required by {RS#396}. Pipe safety-relief-valve discharge line to outside according to ASHRAE Std 15.
9. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.
10. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for device being protected:
 - a. Solenoid valves.
 - b. Thermostatic expansion valves.
 - c. Hot-gas bypass valves.
 - d. Compressor.
11. Install filter dryers in liquid line between compressor and thermostatic expansion valve, and in the suction line at the compressor.
12. Install receivers sized to accommodate pump-down charge.
13. Install flexible connectors at compressors.

3.02 INSTALLATION

A. Piping

1. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.
2. Install refrigerant piping according to ASHRAE Std 15.
3. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
4. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
5. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
6. Install piping adjacent to machines to allow service and maintenance.
7. Install piping free of sags and bends.
8. Install fittings for changes in direction and branch connections.
9. Select system components with pressure rating equal to or greater than system operating pressure.
10. Refer to Division 23 Section 23 09 00 Sections "Instrumentation and Control for HVAC" and Drawings for solenoid valve controllers, control wiring, and sequence of operation.
11. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

12. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Division 08 Section 08 31 13 "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.
 13. Install refrigerant piping in protective conduit where installed below ground.
 14. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.
 15. Slope refrigerant piping as follows:
 - a. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
 - b. Install horizontal suction lines with a uniform slope downward to compressor.
 - c. Install traps and double risers to entrain oil in vertical runs.
 - d. Liquid lines may be installed level.
 16. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.
 17. Before installation of steel refrigerant piping, clean pipe and fittings using the following procedures:
 - a. Shot blast the interior of piping.
 - b. Remove coarse particles of dirt and dust by drawing a clean, lintless cloth through tubing by means of a wire or electrician's tape.
 - c. Draw a clean, lintless cloth saturated with trichloroethylene through the tube or pipe. Continue this procedure until cloth is not discolored by dirt.
 - d. Draw a clean, lintless cloth, saturated with compressor oil, squeezed dry, through the tube or pipe to remove remaining lint. Inspect tube or pipe visually for remaining dirt and lint.
 - e. Finally, draw a clean, dry, lintless cloth through the tube or pipe.
 - f. Safety-relief-valve discharge piping is not required to be cleaned but is required to be open to allow unrestricted flow.
 18. Install pipe sleeves at penetrations in exterior walls and floor assemblies.
 19. Seal penetrations through fire and smoke barriers according to Division 07 Section 07 84 13 "Penetration Firestopping."
 20. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.
 21. Install sleeves through floors, walls, or ceilings, sized to permit installation of full-thickness insulation.
 22. Seal pipe penetrations through exterior walls according to Division 07 Section 07 92 00 "Joint Sealants" for materials and methods.
 23. Identify refrigerant piping and valves according to Division 20 Section 20 05 53 "Identification for Piping and Equipment."
- B. Pipe Joint Construction
1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
 2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
 3. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.
 4. Soldered Joints: Construct joints according to ASTM B828 or CDA's "Copper Tube Handbook."
 5. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
 - a. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.

- b. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.
 - 6. Threaded Joints: Thread steel pipe with tapered pipe threads according to ASME B1.20.1 Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - a. Apply appropriate tape or thread compound to external pipe threads unless dry-seal threading is specified.
 - b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
 - 7. Steel pipe can be threaded, but threaded joints must be seal brazed or seal welded.
 - 8. Welded Joints: Construct joints according to AWS D10.12/D10.12M.
 - 9. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- C. Hangers and Support
 - 1. Hanger, support, and anchor products are specified in Division 20 Section 20 05 29 "Hangers and Supports for Piping and Equipment."
 - 2. Install the following pipe attachments:
 - a. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet (6 m) long.
 - b. Roller hangers and spring hangers for individual horizontal runs 20 feet (6 m) or longer.
 - c. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet (6 m) or longer, supported on a trapeze.
 - d. Spring hangers to support vertical runs.
 - e. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
 - 3. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:
 - a. NPS 1/2 (DN 15): Maximum span, 60 inch (1500 mm); minimum rod size, 1/4 inch (6.4 mm).
 - b. NPS 5/8 (DN 18): Maximum span, 60 inch (1500 mm); minimum rod size, 1/4 inch (6.4 mm).
 - c. NPS 1 (DN 25): Maximum span, 72 inch (1800 mm) 72 inches (1800 mm); minimum rod size, 1/4 inch (6.4 mm).
 - d. NPS 1-1/2 (DN 40) and Smaller NPS 1-1/4 (DN 32): Maximum span, 96 inch (2400 mm); minimum rod size, 3/8 inch (9.5 mm).
 - e. NPS 1-1/2 (DN 40): Maximum span, 96 inch (2400 mm); minimum rod size, 3/8 inch (9.5 mm).
 - f. NPS 2 (DN 50): Maximum span, 96 inch (2400 mm); minimum rod size, 3/8 inch (9.5 mm).
 - g. NPS 2-1/2 (DN 65): Maximum span, 108 inch (2700 mm); minimum rod size, 3/8 inch (9.5 mm).
 - h. NPS 3 (DN 80): Maximum span, 10 feet (3 m); minimum rod size, 3/8 inch (9.5 mm).
 - i. NPS 4 (DN 100): Maximum span, 12 feet (3.7 m); minimum rod size, 1/2 inch (13 mm).
 - 4. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:
 - a. NPS 2 (DN 50): Maximum span, 10 feet (3 m); minimum rod size, 3/8 inch (9.5 mm).
 - b. NPS 2-1/2 (DN 65): Maximum span, 11 feet (3.4 m); minimum rod size, 3/8 inch (9.5 mm).
 - c. NPS 3 (DN 80): Maximum span, 12 feet (3.7 m); minimum rod size, 3/8 inch (9.5 mm).

- d. NPS 4 (DN 100): Maximum span, 11 feet (3.4 m); minimum rod size, 1/2 inch (13 mm).
- 5. Support multifloor vertical runs at least at each floor.

3.03 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Comply with ASME B31.5, Chapter VI.
 - 2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
 - 3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in "Performance Requirements" Article.
 - a. Fill system with nitrogen to the required test pressure.
 - b. System shall maintain test pressure at the manifold gage throughout duration of test.
 - c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
 - d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.
- B. Prepare test and inspection reports.

3.04 ADJUSTING

- A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.
- B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.
- C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.
- D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
 - 1. Open shutoff valves in condenser water circuit.
 - 2. Verify that compressor oil level is correct.
 - 3. Open compressor suction and discharge valves.
 - 4. Open refrigerant valves except bypass valves that are used for other purposes.
 - 5. Check open compressor-motor alignment and verify lubrication for motors and bearings.
- E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

3.05 SYSTEM CHARGING

- A. Charge system using the following procedures:
 - 1. Install core in filter dryers after leak test but before evacuation.
 - 2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers (67 Pa). If vacuum holds for 12 hours, system is ready for charging.
 - 3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig (14 kPa).

END OF SECTION

**SECTION 23 31 00
HVAC DUCTS AND CASINGS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. General
 - 1. Provide ductwork, fittings, hangers, supports, and appurtenances in accordance with NFPA 90A, and SMACNA (DCS) guidelines unless stated otherwise
 - 2. Provide metal duct unless otherwise indicated
 - 3. Seismic Restraint: Fabricate in compliance with local Building and Mechanical Codes; SMACNA (SRM); ASCE 7 requirements; see Section 20 05 48-Vibration and Seismic Controls
 - 4. Seal and install ductwork to seal Class A, except for welded ductwork
 - 5. Fabricate and install ductwork to achieve Leakage classes 3 and 6 for round and rectangular ductwork respectively, unless otherwise noted on Drawings
 - 6. Duct Fabrication Requirements
- B. Metal Ducts
 - 1. Material Requirements
 - 2. Rectangular Metal Duct
 - 3. Flat-Oval Metal Duct
 - 4. Round Metal Duct
 - 5. Connectors, Fittings, Sealants, and Miscellaneous
- C. Flexible Duct
 - 1. Flexible Air Ducts
- D. Non-Metal Ducts
 - 1. Textile Air Dispersion (Sock) Duct:
 - 2. Fibrous Glass Duct
 - 3. Thermoset Fiber Glass Reinforced Plastic (FRP) Duct
 - 4. Phenolic Duct
- E. Air Plenums and Casings
 - 1. Access Doors
 - 2. Thermal Panels
 - 3. Fire-Rated Metal Panels
- F. Duct for Kitchen Exhaust Applications
 - 1. General
 - 2. Dishwasher Exhaust Duct; Type 2
- G. Ducts for Laboratory and Industrial-Grade Applications
 - 1. Duct Class
 - 2. Sectional Shape and Material Requirements
 - 3. Laboratory Exhaust Applications
- H. Prefabricated Ventilation Subducts
 - 1. Single-Wall, Round Ventilation Duct with Integral Subduct Risers
 - 2. Double-Wall, Round, 2-Hour Fire-Rated Ventilation Duct with Integral Subduct Risers
 - 3. Accessories

1.02 REFERENCE STANDARDS

- A. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures; Most Recent Edition Cited by Referring Code or Reference Standard.

- B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2025.
- C. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus; 2019, with Editorial Revision (2023).
- D. ASTM C1071 - Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material); 2019.
- E. ASTM D3363 - Standard Test Method for Film Hardness by Pencil Test; 2022.
- F. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2024.
- G. ICC (IMC) - International Mechanical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- H. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2024.
- I. {RSTEMP#1880}NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems; National Fire Protection Association{CH#98712}.
- J. {RSTEMP#1954}SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible{CH#98721}.
- K. SMACNA (RIDC) - Rectangular Industrial Duct Construction Standards; 2007.
- L. SMACNA (SRM) - Seismic Restraint Manual Guidelines for Mechanical Systems; 2024.
- M. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors; Current Edition, Including All Revisions.
- N. {RSTEMP#2158}UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.
- O. UL 1479 - Standard for Fire Tests of Penetration Firestops; Current Edition, Including All Revisions.

1.03 SUBMITTALS

- A. Action Submittals
 - 1. Product Data: Provide data for duct materials, duct connections, and sealants.
 - 2. Shop Drawings: Indicate duct fitting types, gauges, sizes, welds, and configuration.
 - 3. Manufacturer's Installation Instructions: Indicate special procedures for glass fiber ducts.
- B. Required Embodied Carbon Submittals: All products which satisfy one of the following criteria will require an Embodied Carbon Submittal:
 - 1. The product is a 'Major' piece of equipment
 - 2. The product contains refrigerant
 - 3. The cost of a group of products serving a given function constitutes 5% or greater of the sub-contractor's budget, excluding labor.
- C. Embodied Carbon Submittals
 - 1. Order of Preferred Submittals: For products which require an embodied carbon submittal (described above), one of the following must be provided. The submittal must be that with the highest preference available. The order preference, from highest to lowest is:
 - a. Product Specific, Facility Specific EPD
 - b. Product Specific EPD
 - c. Industry Average EPD
 - d. TM65 Manufacturer Form with Mid-Level Calculation data
 - e. TM65 Manufacturer Form with Basic Calculation data

PART 2 PRODUCTS

2.01 GENERAL

- A. Provide ductwork, fittings, hangers, supports, and appurtenances in accordance with NFPA 90A, and SMACNA (DCS) guidelines unless stated otherwise.
- B. Provide metal duct unless otherwise indicated.
- C. Seismic Restraint: Fabricate in compliance with local Building and Mechanical Codes; SMACNA (SRM); ASCE 7 requirements; see Section 20 05 48 - Vibration and Seismic Controls.
- D. Seal and install ductwork to seal Class A, except for welded ductwork.
- E. Fabricate and install ductwork to achieve Leakage classes 3 and 6 for round and rectangular ductwork respectively, unless otherwise noted on Drawings.
- F. Duct Fabrication Requirements:
 - 1. Duct and Fitting Fabrication and Support: {RS#1954} including specifics for continuously welded round and oval duct fittings.
 - 2. At Contractor's option, ductwork may be resized to maintain an equivalent air velocity and friction rate, while maintaining a maximum aspect ratio of 4.
 - 3. Use reinforced and sealed sheet-metal materials at recommended gauges for indicated operating pressures or pressure class.
 - 4. Construct tees, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline.
 - 5. Where full radius elbows with a radius of not less than 1-1/2 times the width of the duct are not possible, provide round elbows with radius of not less than 1 times the width of the duct. If space conditions do not permit a radius elbow to be installed, use square elbows with multi-blade turning vanes and an access door for cleaning of turning vanes.
 - 6. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
 - 7. Where ducts are connected to exterior wall louvers and duct outlet is smaller than louver frame, provide blank-out panels sealing louver area around duct. Use same material as duct, painted black on exterior side; seal to louver frame and duct.

2.02 METAL DUCTS

- A. Material Requirements:
 - 1. Galvanized Steel: Hot-dipped galvanized steel sheet, ASTM A653/A653M FS Type B, with G90/Z275 coating, minimum 24 gauge except where heavier material is required or specified. Ducts to have mil phosphatized finish for surfaces exposed to view.
- B. Metal Duct Coating Requirements
 - 1. Antimicrobial Coating: Factory- or field-applied in accordance with manufacturer's instructions.
 - a. Manufacturers:
 - 1) MKT Metal Manufaturig
 - b. Apply to the surface of sheet metal that will form the interior surface of the duct. Apply an untreated clear coating to the exterior surface.
 - c. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
 - d. Provide coating with minimum 2H hardness when tested according to ASTM D3363.
 - e. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to {RS#2158}; certified by an NRTL.
- C. Rectangular Metal Ducts:
 - 1. General:
 - 2. Rectangular Single Wall Duct:

- a. Insulation (When Required or Indicated):
 - 1) Thickness: 1 inch (25 mm).
 - 2) Material: Fiberglass.
 - 3) Insulation Covering: mylar liner between inside perforated panel and insulation.
 - 4) Insulation K Value: 0.25 BTU in/(hr-sf F).
 - 5) Insulation Density: _____.
- 3. Rectangular Double Wall Insulated Duct:
 - a. Manufacturers:
 - 1) EHG
 - 2) Linx Industries
 - 3) McGill AirFlow
 - 4) SEMCO
 - b. Construction: Rectangular spiral lock seam duct with galvanized steel outer wall; perforated galvanized steel inner wall; fitting with solid outer wall.
 - c. Insulation (When Required or Indicated):
 - 1) Thickness: 1 inch (25 mm).
 - 2) Material: Fiberglass.
 - 3) Insulation Covering: mylar liner between inside perforated panel and insulation.
 - 4) Insulation K Value: 0.25 BTU in/(hr-sf F).
- D. Round Metal Ducts:
 - 1. General
 - a. Transverse Joints:
 - 1) Transverse joints in ducts larger than 60 inches (1524 mm) in diameter: Flanged.
 - 2) Transverse joints in ducts 60 inches (1524 mm) and smaller in diameter: flanged, beaded sleeve, or draw band joint.
 - b. Longitudinal Seams:
 - 1) Fabricate round ducts larger than 90 inches (2286 mm) in diameter with butt-welded longitudinal seams.
 - 2) Fabricate round ducts 90 inches and smaller in diameter with one of the following based on indicated pressure class:
 - (a) Equal to or greater than +/- 4 inches.
 - (1) Butt Weld Seam.
 - (2) Spiral Seam.
 - (b) Equal to or less than +/- 4 inches.
 - (1) Spiral Seam.
 - (2) Lap and Rivet.
 - (3) Grooved Seam.
 - 3) Exposed ductwork shall be spiral seam unless otherwise noted.
 - 2. Round Single Wall Duct: Round lock seam duct with galvanized steel outer wall.
 - a. Manufacturers:
 - 1) EHG
 - 2) Elgen Manufacturing Company
 - 3) Linx Industries
 - 4) MKT Metal Manufacturing
 - 5) Nordfab Ducting
 - 3. Round Double Wall Insulated Duct: Round spiral lock seam duct with galvanized steel outer wall, perforated galvanized steel inner wall; fitting with the solid inner wall.
 - a. Manufacturers:
 - 1) MKT Metal Manufacturing
 - b. Insulation:

- 1) Thickness: 1 inch (25 mm).
- 2) Material: Fibrous-glass liner complying with ASTM C1071, NFPA 90A or {RS#1880} and with NAIMA AH124, "Fibrous Glass Duct Liner Standard".
- 3) Insulation K Value: 0.25 BTU-in/(hr-sf F).
- 4) Insulation Covering: Mylar liner between inside perforated panel and insulation.
- 5) Insulation Density: _____.
4. Round Connection System: Interlocking duct connection system per {RS#1954}.
5. Round Spiral Duct: Round spiral lock seam duct with galvanized steel outer wall.
- E. Connectors, Fittings, Sealants, and Miscellaneous:
 1. Fittings: Manufacture with solid inner wall of perforated galvanized steel.
 2. Transverse Duct Connection System: SMACNA "E" rated rigid class connection, interlocking angle and duct edge connection system with sealant, gasket, cleats, and corner clips in accordance with {RS#1954}.
 - a. Manufacturers:
 - 1) Carlisle HVAC Products
 - 2) Elgen Manufacturing Company
 - 3) MKT Metal Manufacturing
 3. Joint Sealers and Sealants:
 - a. Non-hardening
 - 1) Manufacturers:
 - (a) Carlisle HVAC Products
 - b. Water resistant
 - 1) Manufacturers:
 - (a) Ductmate Industries
 - (b) Design Polymerics
 - (c) Ductmate Industries
 - (d) Nordfab Ducting
 - (e) Elgen Manufacturing Company
 - (f) H.B. Fuller Construction Products
 - c. Mildew and mold resistant
 - 1) Manufacturers:
 - (a) EHG
 - d. Type: Heavy mastic or liquid used alone or with tape, suitable for joint configuration and compatible with substrates, and recommended by manufacturer for pressure class of ducts.
 - e. VOC Content: Not more than 250 g/L, excluding water.
 - 1) Elgen Manufacturing Company
 - 2) GSI, a DMI Company
 - f. Surface Burning Characteristics: Flame spread index of zero and smoke developed index of zero, when tested in accordance with ASTM E84.
 - g. For Use with Flexible Ducts: UL labeled.
 - 1) Linx Industries
 - 2) MKT Metal Manufacturing
 4. Gasket Tape:
 - a. Manufacturers:
 - b. Provide butyl rubber gasket tape for a flexible seal between transfer duct connector (TDC), transverse duct flange (TDF), applied flange connections, and angle ring connections.
 5. Round Duct Joint O-Ring Seals:
 - a. EPDM O-ring to seal in concave bead in coupling or fitting spigot.

2.03 FLEXIBLE DUCTS

- A. Flexible Air Ducts:
1. Manufacturers:
 - a. Flexmaster USA, a brand of Masterduct, Inc; Type 1
 2. UL 181, Class 1, polyethylene film supported by helically wound spring steel wire.
 3. Insulation: Fiberglass insulation with polyethylene vapor barrier film.
 4. Pressure Rating: From 10 in-wc (2.50 kPa) to 5 in-wc (1.25 kPa) negative.
 5. Maximum Velocity: 5,500 fpm (27.9 m/s).
 6. R-Value: 4.2 when tested in accordance with ASTM C177
 7. Temperature Range: Minus 20 to 250 degrees F (Minus 28 to 121 degrees C).
 8. Insertion Loss: Minimum attenuation of 33 DB for 9-foot straight length at 8-inch diameter at 500Hz.

2.04 AIR PLENUMS AND CASINGS

- A. Fabricate in accordance with {RS#1954} for working pressure of up to 3-inch w.g. (740 Pa) positive or negative and to SMACNA (RIDC) for pressure beyond 3-inch w.g. (750 Pa) positive or negative.
1. Minimum Fabrication Requirements:
 - a. Fabricate acoustic plenum or casing with reinforcing turned inward.
 - b. Provide minimum 16-gauge, 0.059-inch (1.52 mm) sheet steel back facing and 22-gauge, 0.029-inch (0.76 mm) perforated sheet steel front facing with 3/32 inch (2.4 mm) diameter holes on 5/32 inch (4 mm) centers.
 - c. Construct panels 3 inches (75 mm) thick, packed with 4.5 pcf (72 kg/cu m) minimum glass fiber insulation media, on inverted channel of 16-gauge, 0.059-inch (1.52 mm) sheet steel.
 - d. Mount floor-mounted plenum or casings on 4-inch (100 mm) high concrete curbs. At floor, rivet panels on 8-inch (200 mm) centers to angles. Where floors are acoustically insulated, provide liner of galvanized 18-gauge, 0.052-inch (1.31 mm) expanded metal mesh supported at 12-inch (300 mm) centers, turned up 12 inches (300 mm) at sides with sheet metal shields.
 - e. Fabricate casings to withstand 133 percent of the indicated static pressure without structural failure. Limit wall and roof deflection at the indicated static pressure to no more than 1/8 inch per foot (0.97 mm per meter) of width.
 - f. Fabricate outdoor casings to withstand wind load of 15 lbf/sq. ft. (720 N/sq. m) and snow load of 30 lbf/sq. ft. (1440 N/sq. m).
 2. Seismic Performance:
 - a. Casings to withstand the effects of earthquake motions determined in accordance with local Building Codes and ASCE7.
 - b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event;".
 3. Access Doors:
 - a. Install hinged access doors where indicated or required for access to equipment for cleaning and inspection.
 - b. Reinforce door frames with steel angles tied to horizontal and vertical plenum supporting angles.
 - c. Provide clear wire glass observation ports, minimum 6 by 6 inch (150 by 150 mm) size.
 4. Thermal Panels:
 - a. Manufacturers:
 - 1) DuraSystems Barriers
 - b. Material: Steel-faced composite panel with noncombustible structural high density mineral fiber core for plenum fabrication.
 - c. Panel Thickness: 2.5 inches (63 mm).

- d. R-Value: 12 when tested in accordance with ASTM C177.

PART 3 EXECUTION

3.01 APPLICATION

- A. Duct Materials: Use the following materials in the design of ductwork specified in this Section unless otherwise noted on Drawings.
1. General Supply, Return, Transfer, and Exhaust. – galvanized steel.
 2. General Exhaust Branch Serving Air Inlet in Shower Areas or Toilet Room with Shower 304 stainless steel.
 3. Ductwork for the first 15-feet Downstream of Humidifier 304L stainless steel.
 4. Supply, Return, Exhaust serving Natatorium, Pool, or Spa Area 316L stainless steel.
 5. Cryogen relief duct: 304 stainless steel.
 6. Lab exhaust ductwork:
 - a. Lab general exhaust air ductwork from grilles/air registers to air valves/terminal units; 316 stainless steel.
 - b. Lab exhaust air ductwork from fume hoods or biosafety cabinets to air valves/terminal units to main exhaust ductwork, with minimum 12 fume hoods or biosafety cabinets; 316 stainless steel.
 - c. Lab exhaust risers and main ductwork within shafts: welded 316 stainless steel or PVC coated galvanized steel.
- B. Pressure Classes: Fabricate ductwork and casings to the following pressure classes unless otherwise noted on drawings:
1. Medium pressure ductwork, from fan to terminal units: 0.5-inch higher than air handler's Discharge pressure; minimum 6-inch positive pressure class for supply air ductwork; Minimum 6-inch negative pressure class for exhaust or return air ductwork.
 2. Low-pressure ductwork, terminal units to air outlets: plus 2-inch class for supply ductwork, or minus 2-inch for return or exhaust ductwork.
 3. Return and exhaust air ducts on systems without terminal units: 0.5-inch more negative than air handler's design pressure; minimum 2-inch negative pressure class.
 4. Lab medium pressure exhaust ductwork, from fan to lab air valve/terminal units: negative 6-inch pressure class.
 5. Lab low-pressure exhaust ductwork, from lab air valve/terminal units to registers, grilles, and diffusers: negative 2-inch class.
 6. Kitchen exhaust ductwork: negative 6-inch pressure class.
 7. Hazardous exhaust air ductwork: negative 6-inch pressure class.
 8. Ductwork used in smoke management systems: higher of negative 6-inch or 1.5 times max design pressure.
 9. Cryogen relief vent: 10-inch pressure class; maximum 5% leakage.
 10. Hazardous exhaust header upstream of exhaust fan inlet: 10-inch negative class.

3.02 INSTALLATION

- A. General
1. Install, support, and seal ducts in accordance with {RS#1954}.
 2. Where welded ductwork is indicated, welding shall be continuous.
 - a. Tack welding is unacceptable except as specifically noted.
 - b. For galvanized sheet metal ducts, paint welded area and damaged areas with zinc coating after welding.
 3. During construction, provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering the ductwork system.
 4. Protect ductwork exposed to outside elements by painting or coating it with suitable weatherheat-resistant material.
 5. Protect duct interiors from the elements and foreign materials until building is enclosed. Follow SMACNA's Duct Cleanliness for New Construction Advanced Level.

6. Provide ductwork taps and branches off of main and branch ducts at 45 degrees whether shown on Drawings or not (drawings are diagrammatic).
7. Do not cross-break bottom duct panels when ductwork is handling moisture.
8. Roof-mounted ducts shall have standing seams and shall be sealed weather tight.
9. Grade ductwork handling moisture, a minimum of 1:120 (1" in 10 ft) back to the source or at low points in the ductwork, provide a 6" deep drain sump and 1-1/4" dia. drain connection with deep seal trap and pipe to drain.
10. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
11. Duct sizes indicated are precise inside dimensions. For lined ducts, maintain sizes inside lining.
12. Provide openings in ductwork as indicated to accommodate thermometers and controllers. Provide pilot tube openings as indicated for testing of systems, complete with metal can with spring device or screw to insure against air leakage. For openings, insulate ductwork and install insulation material inside a metal ring.
13. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
14. Use crimp joints with or without bead for joining round duct sizes 8-inch (200 mm) or ____ inch (____ mm) and smaller with a crimp in the direction of airflow.
15. Use double nuts and lock washers on threaded rod supports.
16. Connect terminal units to supply ducts directly or with one one foot (300 mm) maximum length of flexible duct. Do not use flexible duct to change direction.
17. Connect diffusers or light troffer boots to low-pressure ducts directly or with 5 feet (1.5 m) maximum length of flexible duct held in place with strap or clamp.
18. Set plenum doors at 6 to 12 inches (150 to 300 mm) above floor. Arrange door swings so that fan static pressure holds door in closed position.
19. At exterior wall louvers, seal duct to louver frame and install blank-out panels.
20. Louver Fit-out:
 - a. Provide blank-out panels sealing available area of wall-mounted exterior-faced louver when connected ductwork is smaller than actual louver free area, and duct outlet is smaller than the louver frame.
 - b. Use the same duct material painted black on the exterior side, then seal louver frame and duct.
21. Fire Partitions: Provide firestopping sealing. See Section 07 84 00.
22. Duct Insulation: Provide duct insulation. See Section 23 07 13.
23. Painting: Provide surface finish as indicated on drawings. See Sections 09 91 13 and 09 91 23.
24. Routing and Locations
 - a. The duct layout shown on the Contract Drawings is diagrammatic in nature. Coordinate ductwork routing and layout, and make alterations to the ductwork routing and layout to eliminate physical interferences. Where deviations in the ductwork routing as shown in the Contract Drawings are required, alterations may be made so as not to compromise the air flow, pressure drop, and sound characteristics of the duct fitting or duct run as shown on the Contract Drawings. In the event, Architect determines that the installed ductwork is inconsistent with the above-mentioned criteria, remove and replace it at no additional cost to the Owner.
 - b. Install ducts, unless otherwise indicated, vertically and horizontally and parallel and perpendicular to building lines; avoid diagonal runs.
 - c. Install ducts with a clearance of 1-inch, plus allowance for insulation thickness. Allow for easy removal of ceiling tiles.
 - d. Do not encase horizontal runs in solid partitions unless specifically indicated.

- e. Coordinate layout with suspended ceiling, air duct accessories, lighting layout and similar finish work.
 - f. Electrical and IT Equipment Spaces: route ducts to avoid passing through transformer vaults, electrical equipment spaces, IDF/MPOE rooms, and enclosures.
 - g. Route ducts to avoid passing through required exit stairwells, exit passageways, elevator hoistways and machinery rooms, transformer vaults, and electrical equipment rooms and enclosures.
- B. Metal Duct
- 1. Paint interiors of metal ducts, that do not have duct liner, for 24-inches upstream of registers and grilles. Apply one coat of flat, black, latex finish coat over a compatible duct material.
- C. Flexible Duct
- 1. Flexible Ducts: Connect to metal ducts with adhesive.
- D. Air Plenums and Casings:
- 1. Mount floor-mounted casings on 4 inch (100 mm) high concrete curbs.
 - 2. At floor, rivet panels on 8 inch (20 mm); or centers to angles.
 - 3. Where floors are acoustically insulated, provide liner of galvanized 18-gauge, 0.052-inch (1.31 mm) expanded metal mesh supported at 12-inch (300 mm) centers, turned up 12 inches (300 mm) at sides with sheet metal shields.

3.03 CLEANING

- A. Clean thoroughly each duct system.
- B. Clean duct system by forcing air at high velocity through duct to remove accumulated dust. Clean half the system at a time to obtain sufficient air. Protect equipment that could be harmed by excessive dirt with temporary filters or bypass during cleaning.
- C. Clean duct systems with high-power vacuum machines. Protect equipment that could be harmed by excessive dirt with filters or bypass during cleaning. Provide adequate access to the ductwork for cleaning purposes.

END OF SECTION

**SECTION 23 33 00
AIR DUCT ACCESSORIES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Backdraft and Pressure Relief Dampers.
- B. Pressure Relief Doors.
- C. Barometric Relief Dampers.
- D. Manual Volume Dampers.
- E. Control Dampers.
- F. Fire Dampers.
- G. Ceiling Radiation Dampers.
- H. Smoke Dampers.
- I. Combination Fire and Smoke Dampers.
- J. Corridor Dampers.
- K. Flange Connectors.
- L. Duct Silencers.
- M. Turning Vanes.
- N. Remote Damper Operations.
- O. Duct-Mounted Access Doors.
- P. Duct Access Panel Assemblies.
- Q. Flexible Connectors.
- R. Duct Security Bars.
- S. Duct Accessory Hardware.
- T. Custom Fabricated Hoods.

1.02 REFERENCE STANDARDS

- A. AMCA 500-D - Laboratory Methods of Testing Dampers for Rating; 2018.
- B. ASHRAE Std 62.1 - Ventilation for Acceptable Indoor Air Quality; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- C. ASHRAE Std 90.1 I-P - Energy Standard for Buildings Except Low-Rise Residential Buildings; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- D. ASTM A480/A480M - Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip; 2023b.
- E. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2025.
- F. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2021a.
- G. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2021.
- H. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric); 2021.

- I. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2024.
- J. ASTM E477 - Standard Test Method for Laboratory Measurements of Acoustical and Airflow Performance of Duct Liner Materials and Prefabricated Silencers; 2020.
- K. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2024.
- L. {RSTEMP#1880}
- M. {RSTEMP#1883}NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations{CH#99392}.
- N. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors; Current Edition, Including All Revisions.
- O. UL 555 - Standard for Fire Dampers; Current Edition, Including All Revisions.
- P. UL 555C - Standard for Safety Ceiling Dampers; Current Edition, Including All Revisions.
- Q. UL 555S - Standard for Smoke Dampers; Current Edition, Including All Revisions.
- R. {RSTEMP#2074}UL 1978 - Grease Ducts;Current Edition, Including All Revisions.

1.03 SUBMITTALS

- A. Action Submittals
 - 1. Product Data: Provide for shop-fabricated assemblies including volume control dampers, duct access doors, duct test holes, and hardware used. Include electrical characteristics and connection requirements.
 - 2. Shop Drawings: Indicate for shop fabricated assemblies including volume control dampers.
 - 3. Manufacturer's Installation Instructions: Provide instructions for fire dampers.
- B. Record Documents

1.04 QUALITY ASSURANCE

1.05 DELIVERY, STORAGE AND HANDLING

- A. Protect dampers from damage to operating linkages and blades.

PART 2 PRODUCTS

2.01 ASSEMBLY DESCRIPTION

- A. Frame: Hat-shaped, 0.05-inch- (1.3-mm-) thick, galvanized sheet steel, with welded corners or mechanically attached and mounting flange.
- B. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with {RS#1880}, "Installation of Warm Air Heating and Air Conditioning Systems."
- C. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- D. Comply with AMCA 500-D testing for damper rating.

2.02 MATERIALS

- A. Galvanized Sheet Steel: Comply with ASTM A653/A653M.
 - 1. Galvanized Coating Designation: G90 (Z275).
 - 2. Exposed-Surface Finish: Mill phosphatized.
- B. Stainless-Steel Sheets: Comply with ASTM A480/A480M, Type 304, and having a No. 2 finish for concealed ducts and finish for exposed ducts.
- C. Aluminum Sheets: Comply with ASTM B209/B209M, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

- D. Extruded Aluminum: Comply with ASTM B221 (ASTM B221M), Alloy 6063, Temper T6.
- E. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- F. Tie Rods: Galvanized steel, 1/4-inch (6-mm) minimum diameter for lengths 36 inches (900 mm) or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches (900 mm)

2.03 BACKDRAFT AND PRESSURE RELIEF DAMPERS

- A. Manufacturers:
 - 1. Air Balance.
 - 2. American Warming and Ventilating.
 - 3. Cesco Products.
 - 4. Duro Dyne.
 - 5. Greenheck Fan Corporation.
 - 6. Nailor Industries.
 - 7. Pottorff.
 - 8. Ruskin Company.
 - 9. SEMCO.
 - 10. Vent Products Company.
- B. Description: Gravity balanced.
- C. Maximum Air Velocity: 1000 fpm (5.1 m/s).
- D. Maximum System Pressure: 1-inch wg (0.25 kPa).
 - 1. Temperature Range: - 20 to + 250 deg F (- 29 to + 121 deg C)
- E. Blades: Multiple single-piece blades, center pivoted, maximum 6-inch (150-mm) width, 0.025-inch- (0.6-mm-) thick, roll-formed aluminum with sealed edges.
- F. Blade Action: Parallel.
- G. Blade Seals: Felt.
- H. Blade Axles:
 - 1. Material: Nonferrous metal.
 - 2. Diameter: 0.20 inch (5 mm).
- I. Tie Bars and Brackets: Galvanized steel.
- J. Return Spring: Adjustable tension.
- K. Bearings: Steel ball.
- L. Accessories:
 - 1. Adjustment device to permit setting for varying differential static pressure.
 - 2. Counterweights and spring-assist kits for vertical airflow installations.
 - 3. Electric actuators.
 - 4. Chain pulls.
 - 5. Screen Mounting: Front mounted in sleeve.
 - a. Sleeve Thickness: 20-gage (1.0-mm) minimum.
 - b. Sleeve Length: 6 inches (152 mm) minimum.
 - 6. Screen Mounting: Rear mounted.
 - 7. Screen Material: Galvanized steel.
 - 8. Screen Type: Bird.
 - 9. 90-degree stops.

2.04 PRESSURE RELIEF DOORS

- A. Manufacturers:
 - 1. Greenheck Fan Corporation.

- 2. Kees.
- 3. Ruskin.
- B. Door and Frame Material: Galvanized sheet steel.
- C. Door: Single wall or Double wall with insulation fill with metal thickness applicable for duct pressure class.
- D. Operation: Open outward for positive-pressure ducts and inward for negative-pressure ducts.
- E. Factory set at 4-inch wg. (1.5 kPa) and adjustable in the field.
- F. Doors close when pressures are within set-point range.
- G. Hinge: Continuous piano.
- H. Latches: Cam.
- I. Seal: Neoprene or foam rubber.
- J. Insulation Fill 1-inch (25.4 mm) fibrous-glass or polystyrene-foam board.

2.05 BAROMETRIC RELIEF DAMPERS

- A. Manufacturers:
 - 1. Air Balance.
 - 2. American Warming and Ventilating.
 - 3. Cesco Products.
 - 4. Duro Dyne.
 - 5. Greenheck Fan Corporation.
 - 6. Nailor Industries.
 - 7. Pottorff.
 - 8. Ruskin Company.
 - 9. SEMCO.
 - 10. Vent Products Company.
- B. Suitable for horizontal or vertical mounting.
- C. Maximum Air Velocity: 1000 fpm (5.1 m/s).
- D. Maximum System Pressure: 2-inch wg (0.5 kPa).
- E. Frame: Hat-shaped, 0.05-inch- (1.3-mm-) thick, galvanized sheet steel, with welded corners or mechanically attached and mounting flange.
- F. Blades:
 - 1. Multiple, 0.025-inch- (0.6-mm-) thick, roll-formed aluminum.
 - 2. Maximum Width: 6 inches (150 mm)
 - 3. Action: Parallel.
 - 4. Balance: Gravity.
 - 5. Eccentrically pivoted.
- G. Blade Seals: Vinyl.
- H. Blade Axles: Galvanized steel.
- I. Tie Bars and Brackets:
 - 1. Material: Aluminum.
 - 2. Rattle free with 90-degree stop.
- J. Return Spring: Adjustable tension.
- K. Bearings: Synthetic.
- L. Accessories:
 - 1. Flange on intake.
 - 2. Adjustment device to permit setting for varying differential static pressures.

2.06 MANUAL VOLUME DAMPERS

- A. Manufacturers:
 - 1. Air Balance.
 - 2. American Warming and Ventilating.
 - 3. Flexmaster U.S.A.
 - 4. Greenheck Fan Corporation.
 - 5. McGill AirFlow.
 - 6. METALAIRE.
 - 7. Nailor Industries.
 - 8. Pottorff.
 - 9. Ruskin Company.
 - 10. Vent Products Company.
- B. Standard, Steel, Manual Volume Dampers:
 - 1. Standard leakage rating , with linkage outside airstream .
 - 2. Suitable for horizontal or vertical applications.
 - 3. Frames:
 - a. Frame: Hat-shaped, 0.094-inch- (2.4-mm-) thick, galvanized sheet steel.
 - b. Mitered and welded corners.
 - c. Flanges for attaching to walls and flangeless frames for installing in ducts.
 - 4. Blades:
 - a. Multiple or single blade.
 - b. Parallel- or opposed-blade design.
 - c. Stiffen damper blades for stability.
 - d. Galvanized-steel,0.064 inch (1.62 mm) thick.
 - 5. Blade Axles: Galvanized steel.
 - 6. Bearings:
 - a. Oil-impregnated bronze.
 - b. Dampers in ducts with pressure classes of 3-inch w.g. (750 Pa) or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
 - 7. Tie Bars and Brackets: Galvanized steel.
- C. Standard, Aluminum, Manual Volume Dampers:
 - 1. Manufacturers:
 - a. Air Balance.
 - b. American Warming and Ventilating.
 - c. Flexmaster U.S.A.
 - d. Greenheck Fan Corporation.
 - e. McGill AirFlow.
 - f. METALAIRE.
 - g. Nailor Industries.
 - h. Pottorff.
 - i. Ruskin Company.
 - j. Vent Products Company.
 - k. Trox USA.
 - 2. Standard leakage rating, with linkage outside airstream.
 - 3. Suitable for horizontal or vertical applications.
 - 4. Frames: Hat-shaped,0.10-inch (2.5-mm-) thick, aluminum sheet channels; frames with flanges for attaching to walls and flangeless frames for installing in ducts.
 - 5. Blades:
 - a. Multiple or single blade.
 - b. Parallel- or opposed-blade design.

- c. Stiffen damper blades for stability.
 - d. Roll-Formed Aluminum Blades: t0.10-inch (2.5-mm-) thick aluminum sheet.
 - e. Extruded-Aluminum Blades: 0.050-inch (1.2-mm) thick extruded aluminum.
- 6. Blade Axles: Galvanized steel.
- 7. Bearings:
 - a. Oil-impregnated bronze.
 - b. Dampers in ducts with pressure classes of 3-inch w.g. (750 Pa) or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
- 8. Tie Bars and Brackets: Aluminum.
- D. Low-Leakage, Steel, Manual Volume Dampers:
 - 1. Manufacturers:
 - a. Air Balance.
 - b. American Warming and Ventilating.
 - c. Flexmaster U.S.A.
 - d. Greenheck Fan Corporation.
 - e. McGill AirFlow.
 - f. METALAIRE.
 - g. Nailor Industries.
 - h. Pottorff.
 - i. Ruskin Company.
 - j. Vent Products Company.
 - k. Flex-Tek Group.
 - l. Trox USA.
 - 2. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
 - 3. Suitable for horizontal or vertical applications.
 - 4. Frames:
 - a. Hat shaped.
 - b. 94-inch- (2.4-mm-) thick, galvanized sheet steel.
 - c. Mitered and welded corners.
 - d. Flanges for attaching to walls and flangeless frames for installing in ducts.
 - 5. Blades:
 - a. Multiple or single blade.
 - b. Parallel- or opposed-blade design.
 - c. Stiffen damper blades for stability.
 - d. Galvanized, roll-formed steel, 0.064 inch (1.62 mm) thick.
 - 6. Blade Axles: Galvanized steel.
 - 7. Bearings:
 - a. Oil-impregnated bronze.
 - b. Dampers in ducts with pressure classes of 3-inch w.g. (750 Pa) or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
 - 8. Blade Seals: Felt.
 - 9. Jamb Seals: Cambered stainless steel.
 - 10. Tie Bars and Brackets: Galvanized steel.
 - 11. Accessories:
 - a. Include locking device with 2" stand-off bracket to hold single-blade dampers in a fixed position without vibration.
- E. Low-Leakage, Aluminum, Manual Volume Dampers:
 - 1. Manufacturers:
 - a. Air Balance Inc.
 - b. American Warming and Ventilating.

- c. Flexmaster U.S.A.
- d. Greenheck Fan Corporation.
- e. McGill AirFlow.
- f. METALAIRE.
- g. Nailor Industries.
- h. Pottorff.
- i. Ruskin Company.
- j. Vent Products Company.
- k. Trox USA.
- 2. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
- 3. Suitable for horizontal or vertical applications.
- 4. Frames: Hat-shaped, 0.10-inch (2.5-mm-) thick, aluminum sheet channels; frames with flanges for attaching to walls and flangeless frames for installing in ducts.
- 5. Blades:
 - a. Multiple or single blade.
 - b. Parallel- or opposed-blade design.
 - c. Roll-Formed Aluminum Blades: 0.10-inch (2.5-mm-) thick aluminum sheet.
- 6. Blade Axles: Galvanized steel.
- 7. Bearings:
 - a. Oil-impregnated bronze.
 - b. Dampers in ducts with pressure classes of 3-inch w.g (750 Pa) less shall have axles full length of damper blades and bearings at both ends of operating shaft.
- 8. Blade Seals: Felt.
- 9. Jamb Seals: Cambered Stainless steel.
- 10. Tie Bars and Brackets: Galvanized steel.
- 11. Accessories:
 - a. Include locking device with 2" stand-off bracket to hold single-blade dampers in a fixed position without vibration.
- F. Jackshaft:
 - 1. Size: 1-inch (25-mm) diameter.
 - 2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
 - 3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.
- G. Damper Hardware:
 - 1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch (2.4-mm) thick zinc-plated steel, and 3/4-inch (19-mm) hexagon locking nut.
 - 2. Include center hole to suit damper operating-rod size.
 - 3. Include elevated platform for insulated duct mounting.

2.07 CONTROL DAMPERS

- A. Manufacturers:
 - 1. American Warming and Ventilating.
 - 2. Cesco Products.
 - 3. Duro Dyne.
 - 4. Greenheck Fan Corporation.
 - 5. McGill AirFlow.
 - 6. METALAIRE.
 - 7. Nailor Industries.
 - 8. Ruskin Company.

- 9. Vent Products Company.
- 10. Young Regulator Company.
- B. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
- C. Frames:
 - 1. Hat shaped.
 - 2. 94-inch- (2.4-mm-) thick, galvanized sheet steel .
 - 3. Mitered and welded corners.
- D. Blades:
 - 1. Multiple blade with maximum blade width of 6 inches (152 mm).
 - 2. Parallel-blade design.
 - 3. Galvanized steel.
 - 4. 4 inch (1.62 mm) thick single skin.
 - 5. Blade Edging: Closed-cell neoprene.
 - 6. Blade Edging: Inflatable seal blade edging, or replaceable rubber seals.
- E. Blade Axles: 1/2-inch- (13-mm-) diameter; Galvanized steel; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.
 - 1. Operating Temperature Range: From- 40 to + 200 deg F (- 40 to + 93 deg C)
- F. Bearings:
 - 1. Oil-impregnated bronze.
 - 2. Dampers in ducts with pressure classes of 3-inch w.g. (750 Pa) or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
 - 3. Thrust bearings at each end of every blade.

2.08 FIRE DAMPERS

- A. Manufacturers:
 - 1. Air Balance Inc.
 - 2. Cesco Products.
 - 3. Greenheck Fan Corporation.
 - 4. McGill AirFlow.
 - 5. METALAIRE.
 - 6. Nailor Industries.
 - 7. Ruskin Company.
 - 8. Vent Products Company,
 - 9. Ward Industries.
- B. Type: Dynamic Static; rated and labeled according to UL 555 by an NRTL.
- C. Fire Rating: 1-1/2 hours.
- D. Frame: Curtain type with blades outside airstream Curtain type with blades inside airstream; fabricated with roll-formed, 0.034-inch- (0.85-mm-) thick galvanized steel; with mitered and interlocking corners.
- E. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
 - 1. Minimum Thickness: 0.05 (1.3 mm) thick, as indicated, and of length to suit application.
 - 2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.
- F. Mounting Orientation: Vertical or horizontal as indicated.
- G. Blades: Roll-formed, interlocking, 0.024-inch- (0.61-mm) thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- (0.85-mm-) thick, galvanized-steel blade connectors.

- H. Horizontal Dampers: Include blade lock and stainless-steel closure spring.
- I. Heat-Responsive Device: Replaceable, 165 deg F (74 deg C) 212 deg F (100 deg C) rated, fusible links.
- J. Heat-Responsive Device: Electric link and switch package, factory installed, 165 deg F (74 deg C) rated.

2.09 SMOKE DAMPERS

- A. Manufacturers:
 - 1. Air Balance.
 - 2. Cesco Products.
 - 3. Greenheck Fan Corporation.
 - 4. Nailor Industries.
 - 5. Ruskin Company.
- B. General Requirements: Label according to UL 555S by an NRTL.
- C. Smoke Detector: Integral, factory wired for single-point connection.
- D. Frame: Hat-shaped, 0.094-inch- (2.4-mm-) thick, galvanized sheet steel, with welded interlocking, gusseted corners and mounting flange.
- E. Blades: Roll-formed, horizontal, interlocking, 0.034-inch- (0.85-mm-) thick, galvanized sheet steel.
- F. Leakage: Class I.
- G. Rated pressure and velocity to exceed design airflow conditions.
- H. Mounting Sleeve: Factory-installed, 0.039-inch- (1.0-mm-) thick, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone caulking.
- I. Damper Motors: Two-position Modulating action.
- J. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 20 Section 20 05 13 "Common Motor Requirements for Mechanical Equipment."
 - 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 - 2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 23 Section 23 09 00 "Instrumentation and Control for HVAC."
 - 3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
 - 4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf (17 N x m) and breakaway torque rating of 150 in. x lbf (17 N x m)
 - 5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at- 40 deg F (- 40 deg C)
 - 6. Nonspring-Return Motors: For dampers larger than 25 sq. ft. (2.3 sq. m) 2 size motor for running torque rating of 150 in. x lbf (17 N x m) and breakaway torque rating of 300 in. x lbf (34 N x m)
 - 7. Electrical Connection: 115 V, single phase, 60 Hz.
- K. Accessories:
 - 1. Auxiliary switches for signaling.
 - 2. Momentary test switch mounted.

2.10 COMBINATION FIRE AND SMOKE DAMPERS

- A. Manufacturers:
 - 1. Air Balance Inc.
 - 2. Cesco Products.
 - 3. Greenheck Fan Corporation.
 - 4. Nailor Industries.
 - 5. Ruskin Company.
- B. Type: Dynamic; rated and labeled according to UL 555 and UL 555S by an NRTL.
- C. Closing rating in ducts up to 4-inch w.g. (1-kPa) static pressure class and minimum 2000-fpm (10-m/s) velocity.
- D. Fire Rating: 1-1/2 hours.
- E. Frame: Hat-shaped, 0.094-inch- (2.4-mm-) thick, galvanized sheet steel, with welded interlocking, gusseted corners and mounting flange.
- F. Heat-Responsive Device: Resettable, 165 deg F (74 deg C) rated, fusible links.
- G. Heat-Responsive Device: Electric Pneumatic resettable link device and switch package, factory installed, rated.
- H. Smoke Detector: Integral, factory wired for single-point connection.
- I. Blades: Roll-formed, horizontal, interlocking, 0.063-inch- (1.6-mm-) thick, galvanized sheet steel.
- J. Leakage: Class I.
- K. Rated pressure and velocity to exceed design airflow conditions.
- L. Mounting Sleeve: Factory-installed, 0.039-inch- (1.0-mm-) thick, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone caulking.
- M. Master control panel for use in dynamic smoke-management systems.
- N. Damper Motors: Two-position Modulating action.
- O. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 20 Section 20 05 13 "Common Motor Requirements for Fire Suppression, Plumbing, and Mechanical Equipment."
 - 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 - 2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 23 Section 23 09 00 "Instrumentation and Control for HVAC."
 - 3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
 - 4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf (17 N x m) and breakaway torque rating of 150 in. x lbf (17 N x m)
 - 5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at - 40 deg F (- 40 deg C)
 - 6. Nonspring-Return Motors: For dampers larger than 25 sq. ft. (2.3 sq. m) 2 size motor for running torque rating of 150 in. x lbf (17 N x m) and breakaway torque rating of 300 in. x lbf (34 N x m)
 - 7. Electrical Connection: 115 V, single phase, 60 Hz.
- P. Accessories:
 - 1. Auxiliary switches for signaling.
 - 2. Momentary test switch mounted.

2.11 FLANGE CONNECTORS

- A. Manufacturers:
 - 1. Ductmate Industries.
 - 2. Elgen.
 - 3. Nexus PDQ.
 - 4. Ward Industries, Inc.
- B. Description: Add-on, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.
- C. Material: Galvanized steel.
- D. Gage and Shape: Match connecting ductwork.

2.12 DUCT SILENCERS

- A. Manufacturers:
 - 1. Industrial Noise Control.
 - 2. McGill AirFlow.
 - 3. Price Industries.
 - 4. Ruskin Company.
 - 5. Vibro-Acoustics.
 - 6. VAW Systems.
- B. General Requirements:
 - 1. Factory fabricated.
 - 2. Fire-Performance Characteristics: Adhesives, sealants, packing materials, and accessory materials shall have flame-spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested according to ASTM E84.
 - 3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE Std 62.1.
- C. Shape:
 - 1. Rectangular straight with splitters or baffles.
 - 2. Round straight with center bodies or pods.
 - 3. Rectangular elbow with splitters or baffles.
 - 4. Round elbow with center bodies or pods.
 - 5. Rectangular transitional with splitters or baffles.
- D. Rectangular Silencer Outer Casing: ASTM A653/A653M, G90 (Z275), galvanized sheet steel, 0.034 inch (0.85 mm) thick.
- E. Round Silencer Outer Casing: ASTM A653/A653M, G90 (Z275), galvanized sheet steel.
 - 1. Sheet Metal Thickness for Units up to 24 Inches (600 mm)) in Diameter: 0.034 inch (0.85 mm) thick.
 - 2. Sheet Metal Thickness for Units 26 through 40 Inches (660 through 1000 mm) in Diameter: 0.040 inch (1.02 mm) thick.
 - 3. Sheet Metal Thickness for Units 42 through 52 Inches (1060 through 1300 mm) in Diameter: 0.052 inch (1.3 mm) thick.
 - 4. Sheet Metal Thickness for Units 54 through 60 Inches (1370 through 1500 mm) in Diameter: 0.064 inch (1.62 mm) thick.
- F. Inner Casing and Baffles: ASTM A653/A653M, G90 (Z275) galvanized sheet metal, 0.034 inch (0.85 mm) thick, and with 1/8-inch- (3-mm-) diameter perforations.
- G. Special Construction:
 - 1. Suitable for outdoor use.
 - 2. High transmission loss to achieve STC 45.
- H. Connection Sizes: Match connecting ductwork unless otherwise indicated.

- I. Principal Sound-Absorbing Mechanism:
 - 1. Controlled impedance membranes and broadly tuned resonators without absorptive media.
 - 2. Dissipative type with fill material.
 - a. Fill Material: Inert and vermin-proof fibrous material, packed under not less than 5 percent compression.
 - b. Erosion Barrier: Polymer bag enclosing fill, and heat sealed before assembly.
 - 3. Lining: None.
- J. Fabricate silencers to form rigid units that will not pulsate, vibrate, rattle, or otherwise react to system pressure variations. Do not use mechanical fasteners for unit assemblies.
 - 1. Joints: Lock formed and sealed.
 - 2. Suspended Units: Factory-installed suspension hooks or lugs attached to frame in quantities and spaced to prevent deflection or distortion.
 - 3. Reinforcement: Cross or trapeze angles for rigid suspension.
- K. Accessories:
 - 1. Integral 1-1/2-hour fire damper with access door. Access door to be high transmission loss to match silencer.
 - 2. Factory-installed end caps to prevent contamination during shipping.
 - 3. Removable splitters.
 - 4. Airflow measuring devices.
- L. Source Quality Control: Test according to ASTM E477.
 - 1. Testing of mockups to be witnessed by Architect.
 - 2. Record acoustic ratings, including dynamic insertion loss and generated-noise power levels with air velocity of at least 2000-fpm (10-m/s) face velocity.
 - 3. Leak Test: Test units for airtightness at 200 percent of associated fan static pressure or 6-inch w.g. (1500-Pa) static pressure, whichever is greater.
- M. Capacities and Characteristics:
 - 1. Configuration: Straight.
 - 2. Shape: Rectangular.
 - 3. Attenuation Mechanism: Acoustical glass fiber.
 - 4. Maximum Pressure Drop: 0.35-inch w.g. (0.09 kPa) .
 - 5. Casing:
 - a. Attenuation: Standard.
 - b. Outer Material: Galvanized steel.
 - c. Inner Material: Galvanized steel.
 - 6. Velocity Range: to .
 - 7. End Connection: 1-inch (25-mm) slip joint.
 - 8. Length: .
 - 9. Face Dimension:
 - a. Width: .
 - b. Height: .
 - 10. Face Velocity: .
 - 11. Dynamic Insertion Loss: .
 - 12. Generated Noise: .
 - 13. Accessories:
 - a. Access door.
 - b. Birdscreen.

2.13 TURNING VANES

- A. Manufacturers:
 - 1. Ductmate Industries.

2. Duro Dyne.
 3. METALAIRE.
 4. SEMCO.
 5. Ward Industries.
- B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.
- C. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
- D. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."
- E. Vane Construction: Single wall.
- F. Vane Construction: Single wall for ducts up to 48 inches (1200 mm) wide and double wall for larger dimensions.

2.14 REMOTE DAMPER OPERATIONS

- A. Manufacturers:
1. Metropolitan Air Technology (MAT).
 2. Pottorff.
 3. Ventfabrics.
 4. Young Regulator Company.
- B. Description: Cable system designed for remote manual damper adjustment.
- C. Tubing: Brass Copper.
- D. Cable: Stainless steel Steel.
- E. Wall-Box Mounting: Recessed, 3/4 inches (19 mm) deep.
- F. Wall-Box Cover-Plate Material: Steel.

2.15 DUCT-MOUNTED ACCESS DOORS

- A. Manufacturers:
1. American Warming and Ventilating.
 2. Cesco Products.
 3. Ductmate Industries.
 4. Flexmaster U.S.A.
 5. Greenheck Fan Corporation.
 6. McGill AirFlow.
 7. Nailor Industries.
 8. Pottorff.
 9. Ruskin.
 10. Ventfabrics.
 11. Ward Industries.
- B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2 (7-2M), "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."
1. Door:
 - a. Double wall, rectangular.
 - b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.

- c. Vision panel.
 - d. Hinges and Latches: 1-by-1-inch (25-by-25-mm) butt or piano hinge and cam latches.
 - e. Fabricate doors airtight and suitable for duct pressure class.
- 2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
- 3. Number of Hinges and Locks:
 - a. Access Doors Less Than 12 Inches (300 mm) Square: No hinges and two sash locks.
 - b. Access Doors up to 18 Inches (460 mm) Square: Two hinges and two sash locks.
 - c. Access Doors up to 24 by 48 Inches (600 by 1200 mm) : Three hinges and and two compression latches with outside and inside handles.
 - d. Access Doors Larger Than 24 by 48 Inches (600 by 1200 mm) : Four hinges and two compression latches with outside and inside handles.
- C. Pressure Relief Access Door:
 - 1. Door and Frame Material: Galvanized sheet steel.
 - 2. Door: Single wall with metal thickness applicable for duct pressure class.
 - 3. Operation: Open outward for positive-pressure ducts and inward for negative-pressure ducts.
 - 4. Factory set at 3.0- to 8.0-inch wg (800 to 2000 Pa).
 - 5. Doors close when pressures are within set-point range.
 - 6. Hinge: Continuous piano.
 - 7. Latches: Cam.
 - 8. Seal: Neoprene or foam rubber.
 - 9. Insulation Fill: 1 inch (25 mm) thick, fibrous-glass or polystyrene-foam board.

2.16 DUCT ACCESS PANEL ASSEMBLIES

- A. Manufacturers:
 - 1. Ductmate Industries.
 - 2. Flame Gard.
 - 3. 3M.
- B. Labeled according to {RS#2074} by an NRTL.
- C. Panel and Frame: Minimum thickness 0.0528-inch (1.3-mm) carbon steel.
- D. Fasteners: Carbon steel. Panel fasteners shall not penetrate duct wall.
- E. Gasket: Comply with {RS#1883}; grease-tight, high-temperature ceramic fiber, rated for minimum .2000 deg F (1093 deg C)
- F. Minimum Pressure Rating: 10-inch w.g. (2500 Pa), positive or negative.

2.17 FLEXIBLE CONNECTORS

- A. Manufacturers:
 - 1. Ductmate Industries.
 - 2. Duro Dyne.
 - 3. Ventfabrics.
 - 4. Ward Industries.
- B. Materials: Flame-retardant or noncombustible fabrics.
- C. Coatings and Adhesives: Comply with UL 181, Class 1.
- D. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches (89 mm) wide attached to 2 strips of 2-3/4-inch- (70-mm-) wide, 0.028-inch- (0.7-mm-) thick, galvanized sheet steel or 0.032-inch- (0.8-mm-) thick aluminum sheets. Provide metal compatible with connected ducts.
- E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
 - 1. Minimum Weight: 26 oz./sq. yd. (880 g/sq. m)

2. Tensile Strength: 480 lbf/inch (84 N/mm) in the warp and 360 lbf/inch (63 N/mm) in the filling.
3. Service Temperature: - 40 to + 200 deg F (- 40 to + 93 deg C)
- F. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
 1. Minimum Weight: 24 oz./sq. yd (810 g/sq. m).
 2. Tensile Strength: 530 lbf/inch (93 N/mm) in the warp and 440 lbf/inch (77 N/mm) in the filling.
 3. Service Temperature: Minus 50 to plus 250 deg F (Minus 45 to plus 121 deg C).
- G. High-Temperature System, Flexible Connectors: Glass fabric coated with silicone rubber.
 1. Minimum Weight: 16 oz./sq. yd. (542 g/sq. m) .
 2. Tensile Strength: 285 lbf/inch (50 N/mm) in the warp and 185 lbf/inch (32 N/mm) in the filling.
 3. Service Temperature: Minus 67 to plus 500 deg F (Minus 55 to plus 260 deg C).
- H. High-Corrosive-Environment System, Flexible Connectors: Glass fabric with chemical-resistant coating.
 1. Minimum Weight: 14 oz./sq. yd. (474 g/sq. m) .
 2. Tensile Strength: 450 lbf/inch (79 N/mm) in the warp and 340 lbf/inch (60 N/mm) in the filling.
 3. Service Temperature: Minus 67 to plus 500 deg F (Minus 55 to plus 260 deg C) .
- I. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.
 1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
 2. Outdoor Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
 7. Coil Spring: Factory set and field adjustable for a maximum of 1/4 inch (6 mm) movement at start and stop.

2.18 DUCT SECURITY BARS

- A. Manufacturers:
 1. Carnes Company.
 2. KEES.
 3. Lloyd Industries.
 4. Metal Form Manufacturing.
 5. Price Industries.
- B. Description: Field-fabricated duct security bars.
- C. Configuration:
 1. Frame: 2 by 1/4 inch (51 by 6 mm) flat frame.
 2. Sleeve: 0.1345-inch 3.4-mm, continuously welded steel frames with 1-by-1-by-3/16-inch (25-by-25-by-4.8-mm) angle frame factory welded to 1 end. To be poured in place or set with concrete block or welded or bolted to wall, one side only. Duct connections on both sides.
 3. Horizontal Bars: 1/2 inch (13 mm).
 4. Vertical Bars: 1/2 inch (13 mm).

5. Bar Spacing: 6 inches (150 mm).
6. Mounting: Metal deck or roofing.

2.19 DUCT ACCESSORY HARDWARE

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of Pitot tube and other testing instruments and of length to suit duct-insulation thickness.
- B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 EXECUTION

3.01 APPLICATION

- A. Backdraft and Pressure Relief Dampers
 1. Install backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
- B. Manual Volume Dampers
 1. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
 - a. Install steel volume dampers in steel ducts.
 - b. Install aluminum volume dampers in aluminum ducts.
 - c. Install stainless steel volume dampers in stainless steel ducts and PVC coated steel ducts.
- C. Duct-Mounted Access Doors:
 1. Provide in the following locations
 - a. On both sides of duct coils.
 - b. Upstream and downstream from duct filters.
 - c. At outdoor-air intakes and mixed-air plenums.
 - d. At drain pans and seals.
 - e. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
 - f. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
 - g. At each change in direction and at maximum 50-foot (15-m) spacing.
 - h. Upstream and downstream from turning vanes.
 - i. Upstream or downstream from duct silencers.
 - j. Control devices requiring inspection.
 - k. Elsewhere as indicated.
 2. Access Door Sizes:
 - a. Two-Hand Access: 12 by 6 inches (300 by 150 mm).
 - b. Head and Hand Access: 18 by 10 inches (460 by 250 mm).
 - c. Head and Shoulders Access: 21 by 14 inches (530 by 355 mm).
 - d. Body Access: 25 by 14 inches (635 by 355 mm).
 - e. Body plus Ladder Access: 25 by 17 inches (635 by 430 mm).
- D. Flexible Connectors
 1. Install flexible connectors to connect ducts to equipment.
- E. Duct Accessory Hardware

1. Instrument Test Holes:
 - a. Install test holes at fan inlets and outlets and elsewhere as indicated.
 - b. Install duct test holes where required for testing and balancing purposes.

3.02 INSTALLATION

- A. General
 1. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
 2. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
 3. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch (6-mm) movement during start and stop of fans.
- B. Manual Volume Dampers: Set dampers to fully open position before testing, adjusting, and balancing.
- C. Fire, Smoke and Combination Fire and Smoke Dampers: Install according to UL listing.
- D. Duct-Mounted Access Doors:
 1. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
 2. Label access doors according to Division 20 Section 20 05 53 "Mechanical Identification" to indicate the purpose of access door.
- E. Flexible Connectors: For fans developing static pressures of 5-inch w.g. (1250 Pa) and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.
- F. Duct Security Bars: Install duct security bars. Construct duct security bars from 0.164-inch (4.18-mm) steel sleeve, continuously welded at all joints and 1/2-inch (13-mm) diameter steel bars, 6 inches (150 mm) o.c. in each direction in center of sleeve. Weld each bar to steel sleeve and each crossing bar. Weld 2-1/2-by-2-1/2-by-1/4-inch (63-by-63-by-6-mm) steel angle to 4 sides and both ends of sleeve. Connect duct security bars to ducts with flexible connections. Provide 12-by-12-inch (300-by-300-mm) hinged access panel with cam lock in duct in each side of sleeve.
- G. Duct Silencers: Connect ducts to duct silencers with flexible duct connectors.

3.03 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 1. Manual and Control Dampers: Operate dampers to verify full range of movement.
 2. Duct-Mounted Access Doors: Inspect locations of access doors and verify that purpose of access door can be performed.
 3. Fire, Smoke, and Combination Fire and Smoke Dampers: Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
 4. Turning Vanes: Inspect turning vanes for proper and secure installation.
 5. Remote Damper Operators: Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION

SECTION 23 34 16
CENTRIFUGAL HVAC FANS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Airfoil Centrifugal Fans.
- B. Backward-Inclined Centrifugal Fans.
- C. Forward-Curved Centrifugal Fans.
- D. Plenum Fans.
- E. Plug Fans.
- F. Motors.

1.02 GENERAL REFERENCES

- A. Division 20, including all Common Mechanical Requirements in Section 20 00 00, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.

1.03 RELATED REQUIREMENTS

- A. Section 23 05 13 - Common Motor Requirements for HVAC Equipment.
- B. Section 23 05 48 - Vibration and Seismic Controls for HVAC.
- C. Section 23 07 13 - Duct Insulation.
- D. Section 23 33 00 - Air Duct Accessories: Backdraft dampers.

1.04 REFERENCE STANDARDS

- A. ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings; American Bearing Manufacturers Association, Inc.; Approved Edition.
- B. ABMA STD 11 - Load Ratings and Fatigue Life for Roller Bearings; 2014 (Reaffirmed 2020).
- C. AMCA 99 - Standards Handbook; 2016.
- D. AMCA 210 - Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating; 2016.
- E. AMCA 300 - Reverberant Room Method for Sound Testing of Fans; 2014.
- F. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data; 2022.
- G. ASHRAE 51 - Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating; 2025.
- H. ASHRAE Std 62.1 - Ventilation for Acceptable Indoor Air Quality; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- I. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.05 SUBMITTALS

- A. Action Submittals
 - 1. Product Data: Provide data on centrifugal fans and accessories including fan curves with specified operating point plotted, power, rpm, sound power levels for both fan inlet and outlet at rated capacity, and electrical characteristics and connection requirements.
 - 2. Shop Drawings: Indicate assembly of centrifugal fans and accessories including fan curves with specified operating point plotted, sound power levels for both fan inlet and outlet at rated capacity, and electrical characteristics and connection requirements.
 - 3. Manufacturer's Instructions: Include complete installation instructions.

- B. Operation and Maintenance Materials
 - 1. Include instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.
- C. Record Documents

1.06 QUALITY ASSURANCE

- A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.
- B. AMCA Compliance:
 - 1. Comply with AMCA performance requirements and bear the AMCA-Certified Ratings Seal.
 - 2. Operating Limits: Classify according to AMCA 99.
- C.

1.07 DELIVERY, STORAGE AND HANDLING

- A. Protect motors, shafts, and bearings from weather and construction dust.

1.08 EXTRA MATERIALS

PART 2 PRODUCTS

2.01 GENERAL

- A. Manufacturers
 - 1. ABB Fan Group North America.
 - 2. Aerovent.
 - 3. Bayley Fans.
 - 4. Carrier Corporation.
 - 5. Chicago Blower Corporation.
 - 6. Cincinnati Fan.
 - 7. CML Northern Blower.
 - 8. Howden Buffalo.
 - 9. Loren Cook Company.
 - 10. New York Blower Company.
 - 11. Trane.
- B. Motors
 - 1. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Division 20 Section 20 05 13 "Common Motor Requirements for Mechanical Equipment."
- C. Source Quality Control
 - 1. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.
 - 2. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210/ASHRAE 51, "Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating."

2.02 AIRFOIL CENTRIFUGAL FANS

- A. Description:
 - 1. Factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure.
 - 2. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations.
 - 3. Factory-installed and -wired disconnect switch.

- B. Housings:
 - 1. Formed panels to make curved-scroll housings with shaped cutoff.
 - 2. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
 - 3. Horizontally split, bolted-flange housing.
 - 4. Spun inlet cone with flange.
 - 5. Outlet flange.
- C. Airfoil Wheels:
 - 1. Single-width-single-inlet and double-width-double-inlet construction with curved inlet flange.
 - 2. Heavy backplate.
 - 3. Hollow die-formed, airfoil-shaped blades continuously welded at tip flange and backplate.
 - 4. Cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws.
- D. Shafts:
 - 1. Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with adjustable alignment and belt tensioning.
 - 2. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
 - 3. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
- E. Prelubricated and Sealed Shaft Bearings:
 - 1. Self-aligning, pillow-block-type bearings.
 - 2. Ball-Bearing Rating Life: ABMA STD 9 , L10 at 50,000 hours .
 - 3. Roller-Bearing Rating Life: ABMA STD 11, L10 at 50,000 hours .
- F. Grease-Lubricated Shaft Bearings:
 - 1. Self-aligning, pillow-block-type, tapered roller bearings with double-locking collars and two-piece, cast-iron housing.
 - 2. Ball-Bearing Rating Life: ABMA STD 9 , L10 at 50,000 hours .
 - 3. Roller-Bearing Rating Life: ABMA STD 11, L10 at 50,000 hours .
- G. Grease-Lubricated Shaft Bearings:
 - 1. Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.
 - 2. Ball-Bearing Rating Life: ABMA STD 9 , L10 at 50,000 hours .
 - 3. Roller-Bearing Rating Life: ABMA STD 11, L10 at 50,000 hours .
- H. Belt Drives:
 - 1. Factory mounted, with adjustable alignment and belt tensioning.
 - 2. Service Factor Based on Fan Motor Size: 1.5.
 - 3. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
 - 4. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
 - 5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
 - 6. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
 - 7. Motor Mount: Adjustable for belt tensioning.
- I. Accessories:

1. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE Std 62.1.
2. Scroll Drain Connection: NPS 1 (DN 25) steel pipe coupling welded to low point of fan scroll.
3. Companion Flanges: Rolled flanges for duct connections of same material as housing.
4. Variable Inlet Vanes: With blades supported at both ends with two permanently lubricated bearings of same material as housing. Variable mechanism terminating in single control lever with control shaft for double-width fans.
5. Discharge Dampers: Assembly with parallel blades constructed of two plates formed around and to shaft, channel frame, and sealed ball bearings; with blades linked outside of airstream to single control lever of same material as housing.
6. Inlet Screens: Grid screen of same material as housing.
7. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
8. Spark-Resistant Construction: AMCA 99.
9. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.
10. Weather Cover: Enameled-steel sheet with ventilation slots, bolted to housing.

2.03 BACKWARD-INCLINED CENTRIFUGAL FANS

- A. Description:
 1. Factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure.
 2. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations.
 3. Factory-installed and -wired disconnect switch.
- B. Housings:
 1. Formed panels to make curved-scroll housings with shaped cutoff.
 2. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
 3. Horizontally split, bolted-flange housing.
 4. Spun inlet cone with flange.
 5. Outlet flange.
- C. Backward-Inclined Wheels:
 1. Single-width-single-inlet and double-width-double-inlet construction with curved inlet flange, backplate, backward-inclined blades, and fastened to shaft with set screws.
 2. Welded or riveted to flange and backplate; cast-iron or cast-steel hub riveted to backplate.
- D. Shafts:
 1. Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with adjustable alignment and belt tensioning.
 2. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
 3. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
- E. Prelubricated and Sealed Shaft Bearings:
 1. Self-aligning, pillow-block-type ball bearings.
 2. Ball-Bearing Rating Life: ABMA STD 9 , L10 at 50,000 hours .
 3. Roller-Bearing Rating Life: ABMA STD 11, L10 at 50,000 hours .
- F. Grease-Lubricated Shaft Bearings:
 1. Self-aligning, pillow-block-type, tapered roller bearings with double-locking collars and two-piece, cast-iron housing.
 2. Ball-Bearing Rating Life: ABMA STD 9 , L10 at 50,000 hours .

3. Roller-Bearing Rating Life: ABMA STD 11, L10 at 50,000 hours .
- G. Grease-Lubricated Shaft Bearings:
 1. Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.
 2. Ball-Bearing Rating Life: ABMA STD 9 , L10 at 50,000 hours .
 3. Roller-Bearing Rating Life: ABMA STD 11, L10 at 50,000 hours .
- H. Belt Drives:
 1. Factory mounted, with adjustable alignment and belt tensioning.
 2. Service Factor Based on Fan Motor Size: 1.5.
 3. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
 4. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
 5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
 6. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
 7. Motor Mount: Adjustable for belt tensioning.
- I. Accessories:
 1. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE Std 62.1.
 2. Scroll Drain Connection: NPS 1 (DN 25) steel pipe coupling welded to low point of fan scroll.
 3. Companion Flanges: Rolled flanges for duct connections of same material as housing.
 4. Variable Inlet Vanes: With blades supported at both ends with two permanently lubricated bearings of same material as housing. Variable mechanism terminating in single control lever with control shaft for double-width fans.
 5. Discharge Dampers: Assembly with parallel blades constructed of two plates formed around and to shaft, channel frame, and sealed ball bearings; with blades linked outside of airstream to single control lever of same material as housing.
 6. Inlet Screens: Grid screen of same material as housing.
 7. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
 8. Spark-Resistant Construction: AMCA 99.
 9. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.
 10. Weather Cover: Enameled-steel sheet with ventilation slots, bolted to housing.

2.04 FORWARD-CURVED CENTRIFUGAL FANS

- A. Description:
 1. Factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure.
 2. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations.
 3. Factory-installed and -wired disconnect switch.
- B. Housings:
 1. Formed panels to make curved-scroll housings with shaped cutoff.
 2. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
 3. Horizontally split, bolted-flange housing.

4. Spun inlet cone with flange.
5. Outlet flange.
- C. Forward-Curved Wheels:
 1. Black-enameled or galvanized-steel construction with inlet flange, backplate, shallow blades with inlet and tip curved forward in direction of airflow.
 2. Mechanically secured to flange and backplate; cast-steel hub swaged to backplate and fastened to shaft with set screws.
- D. Shafts:
 1. Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with adjustable alignment and belt tensioning.
 2. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
 3. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
- E. Prelubricated and Sealed Shaft Bearings:
 1. Self-aligning, pillow-block-type ball bearings.
 2. Ball-Bearing Rating Life: ABMA STD 9 , LI0 at 50,000 hours .
 3. Roller-Bearing Rating Life: ABMA STD 11, LI0 at 50,000 hours .
- F. Grease-Lubricated Shaft Bearings:
 1. Self-aligning, pillow-block-type, tapered roller bearings with double-locking collars and two-piece, cast-iron housing.
 2. Ball-Bearing Rating Life: ABMA STD 9 , LI0 at 50,000 hours .
 3. Roller-Bearing Rating Life: ABMA STD 11, LI0 at 50,000 hours .
- G. Grease-Lubricated Shaft Bearings:
 1. Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.
 2. Ball-Bearing Rating Life: ABMA STD 9 , LI0 at 50,000 hours .
 3. Roller-Bearing Rating Life: ABMA STD 11, LI0 at 50,000 hours .
- H. Belt Drives:
 1. Factory mounted, with adjustable alignment and belt tensioning.
 2. Service Factor Based on Fan Motor Size: 1.5.
 3. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
 4. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
 5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
 6. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
 7. Motor Mount: Adjustable for belt tensioning.
- I. Accessories:
 1. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE Std 62.1.
 2. Scroll Drain Connection: NPS 1 (DN 25) steel pipe coupling welded to low point of fan scroll.
 3. Companion Flanges: Rolled flanges for duct connections of same material as housing.

4. Variable Inlet Vanes: With blades supported at both ends with two permanently lubricated bearings of same material as housing. Variable mechanism terminating in single control lever with control shaft for double-width fans.
5. Discharge Dampers: Assembly with parallel blades constructed of two plates formed around and to shaft, channel frame, and sealed ball bearings; with blades linked outside of airstream to single control lever of same material as housing.
6. Inlet Screens: Grid screen of same material as housing.
7. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
8. Spark-Resistant Construction: AMCA 99.
9. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.
10. Weather Cover: Enameled-steel sheet with ventilation slots, bolted to housing.

2.05 PLENUM FANS

- A. Description:
 1. Factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fans consisting of wheel, fan shaft, bearings, motor, drive assembly, and support structure.
 2. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations.
 3. Factory-installed and -wired disconnect switch.
- B. Airfoil Wheels:
 1. Single-width-single-inlet construction with smooth-curved inlet flange.
 2. Heavy backplate.
 3. Hollow die-formed, airfoil-shaped blades continuously welded at tip flange and backplate.
 4. Cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws.
- C. Shafts:
 1. Statically and dynamically balanced and selected for continuous operation at maximum-rated fan speed and motor horsepower, with adjustable alignment and belt tensioning.
 2. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
 3. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
- D. Prelubricated and Sealed Shaft Bearings:
 1. Self-aligning, pillow-block-type ball bearings.
 2. Ball-Bearing Rating Life: ABMA STD 9 , LI0 at 50,000 hours .
 3. Roller-Bearing Rating Life: ABMA STD 11, LI0 at 50,000 hours .
- E. Grease-Lubricated Shaft Bearings:
 1. Self-aligning, pillow-block-type, tapered roller bearings with double-locking collars and two-piece, cast-iron housing.
 2. Ball-Bearing Rating Life: ABMA STD 9 , LI0 at 50,000 hours .
 3. Roller-Bearing Rating Life: ABMA STD 11, LI0 at 50,000 hours .
- F. Grease-Lubricated Shaft Bearings:
 1. Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.
 2. Ball-Bearing Rating Life: ABMA STD 9 , LI0 at 50,000 hours .
 3. Roller-Bearing Rating Life: ABMA STD 11, LI0 at 50,000 hours .
- G. Belt Drives:
 1. Factory mounted, with adjustable alignment and belt tensioning.
 2. Service Factor Based on Fan Motor Size: 1.5.
 3. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.

4. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
 5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
 6. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
 7. Motor Mount: Adjustable for belt tensioning.
- H. Accessories:
1. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
 2. Spark-Resistant Construction: AMCA 99.
 3. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install centrifugal fans level and plumb.
- B. Disassemble and reassemble units, as required for moving to the final location, according to manufacturer's written instructions.
- C. Lift and support units with manufacturer's designated lifting or supporting points.
- D. Equipment Mounting:
 1. Install centrifugal fans on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Division 03 Section 03 30 00 "Cast-in-Place Concrete."
 2. Comply with requirements for vibration isolation and seismic control devices specified in Division 20 Section 20 05 48 "Vibration and Seismic Controls."
 3. Comply with requirements for vibration isolation devices specified in Division 20 Section 20 05 48 "Vibration Controls."
- E. Curb Support: Install roof curb on roof structure, level and secure, according to "The NRCA Roofing and Waterproofing Manual," Low-Slope Membrane Roofing Construction Details Section, Illustration "Raised Curb Detail for Rooftop Air Handling Units and Ducts." Install and secure centrifugal fans on curbs, and coordinate roof penetrations and flashing with roof construction. Secure units to curb support with anchor bolts.
- F. Unit Support: Install centrifugal fans level on structural curbs. Coordinate wall penetrations and flashing with wall construction. Secure units to structural support with anchor bolts.
- G. Isolation Curb Support: Install centrifugal fans on isolation curbs, and install flexible duct connectors and vibration isolation and seismic-control devices.
 1. Comply with requirements in Division 23 Section 23 33 00 "Air Duct Accessories" for flexible duct connectors.
 2. Comply with requirements in Division 20 Section 20 05 48 "Vibration and Seismic Controls" for vibration isolation and seismic-control devices.
- H. Install units with clearances for service and maintenance.
- I. Label fans according to requirements specified in Division 20 Section 20 05 53 "Mechanical Identification."

3.02 CONNECTIONS

- A. Duct Connections
 1. Install ducts adjacent to fans to allow service and maintenance.
 2. Make final duct connections with flexible connectors.

- B. Electrical Connections
- C. Control Connections

3.03 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Verify that shipping, blocking, and bracing are removed.
 - 2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
 - 3. Verify that cleaning and adjusting are complete.
 - 4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
 - 5. Adjust belt tension.
 - 6. Adjust damper linkages for proper damper operation.
 - 7. Verify lubrication for bearings and other moving parts.
 - 8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
 - 9. See Division 20 Section 20 05 93 "Testing, Adjusting, and Balancing" for testing, adjusting, and balancing procedures.
 - 10. Remove and replace malfunctioning units and retest as specified above.
- D. Test and adjust controls and safeties. Controls and equipment will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.

3.04 DEMONSTRATION AND TRAINING

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain centrifugal fans.

END OF SECTION

SECTION 23 37 13
AIR OUTLETS AND INLETS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. General Grilles, Registers and Diffusers
 - 1. Round Ceiling Diffusers.
 - 2. Rectangular Ceiling Diffusers.
 - 3. Perforated Face Ceiling Diffusers.
 - 4. Ceiling Slot Diffusers.
 - 5. Light Troffer Diffusers.
 - 6. Duct-Mounted Supply And Return Registers/Louvers.
 - 7. Ceiling Supply Registers/Grilles.
 - 8. Ceiling Exhaust And Return Registers/Grilles.
 - 9. Ceiling Linear Exhaust And Return Grilles.
 - 10. Ceiling Egg Crate Exhaust And Return Grilles.
 - 11. VAV Diffusers
 - 12. Wall Supply Registers/Grille.
 - 13. Wall Exhaust And Return Registers/Grilles.
 - 14. Wall Grid And Core Exhaust and Return Registers/Grilles.
 - 15. Wall and Ceiling Gypsum Board Access Panels With Return Air Grilles.
 - 16. Linear Wall Registers/Grilles.
 - 17. Linear Floor Supply Registers/Grilles.
 - 18. Floor Supply Registers/Grilles.
 - 19. Door Grilles.
- B. Critical Environments Diffusers.
 - 1. Laminar Flow Diffusers
 - 2. Operating Room Particulate Control Diffusers
 - 3. Radial Flow Diffusers
 - 4. Operating Room, Integrated Ceiling Systems
- C. Fan Filter Units.
- D. Room Exhaust Hoods
- E. Louvers and Penthouses
 - 1. Louvers.
 - 2. Industrial Fiberglass Louvers.
 - 3. Air Measuring Station Louvers.
 - 4. Combination Louvers.
 - 5. Louvered Penthouses.
 - 6. Roof Hoods.
 - 7. Goosenecks.
- F. Gravity Ventilators.
 - 1. Hood Intake and Relief Gravity Ventilator:
 - 2. Spun Aluminum Intake and Relief Gravity Ventilator:
 - 3. Non-Powered Gravity Upblast Roof Ventilator:
 - 4. Extruded Aluminum Intake Ventilator:

1.02 RELATED REQUIREMENTS

- A. Section 09 91 23 - Interior Painting: Painting of ducts visible behind outlets and inlets.

1.03 REFERENCE STANDARDS

- A. AHRI 880 (I-P) - Performance Rating of Air Terminals; 2017 (Reaffirmed 2023).
- B. AMCA 500-L - Laboratory Methods of Testing Louvers for Rating; 2012, with Editorial Revision (2015).
- C. AMCA 511 - Certified Ratings Program Product Rating Manual for Air Control Devices; 2021, with Editorial Revision (2022).
- D. AMCA 550 - Test Method for High Velocity Wind Driven Rain Resistant Louvers; 2022.
- E. ASHRAE Std 70 - Method of Testing the Performance of Air Outlets and Air Inlets; 2006 (Reaffirmed 2021).
- F. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2021.
- G. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric); 2021.
- H. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2024.
- I. SMACNA (ASMM) - Architectural Sheet Metal Manual; 2012.
- J. {RSTEMP#1954}SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible{CH#102169}.

1.04 SUBMITTALS

- A. Action Submittals
 - 1. Product Data: Provide data for equipment required for this project. Review outlets and inlets as to size, finish, and type of mounting prior to submission. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.
- B. Operation and Maintenance Materials
- C. Record Documents

1.05 QUALITY ASSURANCE

- A. Test and rate air outlet and inlet performance in accordance with ASHRAE Std 70.
- B. Test and rate louver performance in accordance with AMCA 500-L.

1.06 MOCK-UPS AND SAMPLES

- A. Samples: Submit two of each required air outlet and inlet type.
- B. Provide mock-up of typical exterior ceiling module with supply and return air outlets.
- C. Locate where directed.
- D. Mock-up may remain as part of the Work.

PART 2 PRODUCTS

2.01 GENERAL GRILLES, REGISTERS AND DIFFUSERS

- A. Manufacturers
 - 1. American Louver Company
 - 2. Carnes
 - 3. EHG
 - 4. Krueger
 - 5. Linx Industries
 - 6. Metalaire
 - 7. Price Industries
 - 8. Prihoda
 - 9. Ruskin
 - 10. Titus
 - 11. Tuttle and Bailey

B. Round Ceiling Diffusers

1. Type: Round, adjustable pattern, stamped or spun, multicore diffuser to discharge air in 360-degree pattern, with sectorizing baffles where indicated. Project diffuser collar not more than 1 inch (25 mm) above ceiling. In plaster ceilings, provide plaster ring and ceiling plaque.
2. Fabrication: Steel with baked enamel finish.
3. Color: As indicated.
4. Color: As selected by Architect from manufacturer's standard range.
5. Accessories: Radial opposed blade damper and multi-louvered equalizing grid with damper adjustable from diffuser face.

C. Rectangular Ceiling Diffusers

1. Type: Provide rectangular and square formed adjustable, backpan stamped, core removable, and multi-louvered ceiling diffusers constructed to maintain 360 degree discharge air pattern with sectorizing baffles where indicated.
2. Devices shall be designed for variable.
3. Connections: Round.
4. Frame: Provide surface mount, snap-in, inverted T-bar, and spline type. In plaster ceilings, provide plaster frame and ceiling frame.
5. Fabrication: Steel with baked enamel finish.
6. Color: As indicated.
7. Color: As selected by Architect from manufacturer's standard range.
8. Accessories: Provide radial opposed blade, butterfly, and combination splitter volume control damper; removable core, sectorizing baffle, safety chain, wire guard, equalizing grid, operating rod extension, anti-smudging device, and gaskets for surface mounted diffusers with damper adjustable from diffuser face.

D. Duct-Mounted Supply and Return Registers/Louvers

1. Type: Duct-mounted, rectangular register for round-spiral duct with adjustable pivot-ended blades, end caps, built-in volume damper, and dual cover flanges to lay flush on duct surface regardless of diameter. Performance to match manufacturer's catalog data.
2. Material: 22 gauge, 0.0299 inch (0.76 mm).
 - a. Provide crossing spiral fitting-body of matching duct diameter.
3. Color: As indicated on drawings.

E. Ceiling Supply Registers/Grilles

1. Type: Streamlined and individually adjustable curved blades to discharge air along face of grille, one-way deflection.
2. Frame: 1-1/4 inch (32 mm) margin with countersunk screw mounting and gasket.
3. Construction: Made of aluminum extrusions with factory enamel finish.
4. Construction: Made of stainless steel.
5. Color: As indicated.
6. Color: As selected by Architect from manufacturer's standard range.
7. Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face.

F. Ceiling Exhaust and Return Registers/Grilles

1. Type: Streamlined blades, 3/4 inch (19 mm) minimum depth, 3/4 inch (19 mm) maximum spacing, with blades set at 45 degrees, vertical face.
2. Frame: 1-1/4 inch (32 mm) margin with countersunk screw mounting.
3. Fabrication: Steel with 20 gauge, 0.0359 inch (0.91 mm) minimum frames and 22 gauge, 0.0299 inch (0.76 mm) minimum blades, steel and aluminum with 20 gauge, 0.0359 inch (0.91 mm) minimum frame, or aluminum extrusions, with factory baked enamel finish.

4. Fabrication: Stainless steel with 20 gauge, 0.0359 inch (0.91 mm) minimum frames and 22 gauge, 0.0299 inch (0.76 mm) minimum blades, steel and aluminum with 20 gauge, 0.0359 inch (0.91 mm) minimum frame.
 5. Color: As indicated.
 6. Color: To be selected by Architect from manufacturer's standard range.
 7. Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face where not individually connected to exhaust fans.
 8. Gymnasiums: Provide front pivoted or welded in place blades, securely fastened to be immobile.
- G. Ceiling Linear Exhaust and Return Grilles
1. Type: Streamlined blades with 90 degree one-way deflection, 1/8 by 3/4 inch (3.2 by 19 mm) on 1/4 inch (6 mm) centers.
 2. Frame: 1-1/4 inch (32 mm) margin, extra heavy for floor mounting, with countersunk screw mounting.
 3. Fabrication: Steel with 20 gauge, 0.0359 inch (0.91 mm) minimum frames and 22 gauge, 0.0299 inch (0.76 mm) minimum blades, steel and aluminum with 20 gauge, 0.0359 inch (0.91 mm) minimum frame, or aluminum extrusions, with factory baked enamel finish.
 4. Color: As indicated.
 5. Color: To be selected by Architect from manufacturer's standard range.
 6. Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face.
- H. Ceiling Egg Crate Exhaust and Return Grilles
1. Basis of Design: Krueger-HVAC; EGCX: www.krueger-hvac.com/#sle.
 2. Type: Egg crate style face consisting of 1/2 by 1/2 by 1/2 inch (13 by 13 by 13 mm) grid core.
 3. Fabrication: Grid core consists of aluminum with mill aluminum finish.
 4. Color: To be selected by Architect from manufacturer's standard range.
 5. Frame: 1-1/4 inch (32 mm) margin with countersunk screw mounting.
 6. Frame: Channel lay-in frame for suspended grid ceilings.
 7. Accessories: Provide integral gang and face operated opposed blade damper, 2 inch filter frame (50 mm), plaster frame, square mesh insect screen, square mesh debris screen, prescored molded fiberglass back, and 45 degree angled eggcrate or other similar provisions for visual blocking such as angled louver or 90 degree duct elbow.
- I. Wall Supply Registers/Grilles
1. Type: Streamlined and individually adjustable blades, 3/4 inch (19 mm) minimum depth, 3/4 inch (19 mm) maximum spacing with spring or other device to set blades, vertical face, single deflection.
 2. Type: Streamlined and individually adjustable curved blades to discharge air along face of grille with one-way deflection.
 3. Frame: 1-1/4 inch (32 mm) margin with countersunk screw mounting and gasket.
 4. Fabrication: Steel with 20 gauge, 0.0359 inch (0.91 mm) minimum frames and 22 gauge, 0.0299 inch (0.76 mm) minimum blades, steel and aluminum with 20 gauge, 0.0359 inch (0.91 mm) minimum frame, or aluminum extrusions, with factory baked enamel finish.
 5. Fabrication: Aluminum extrusions with factory clear lacquer finish.
 6. Color: As indicated.
 7. Color: To be selected by Architect from manufacturer's standard range.
 8. Damper: Integral, gang-operated opposed blade type with removable key operator, operable from face.
 9. Gymnasiums: Provide front pivoted or welded in place blades, securely fastened to be immobile.
- J. Wall Exhaust and Return Registers/Grilles

1. Type: Streamlined blades, 3/4 inch (19 mm) minimum depth, 3/4 inch (19 mm) maximum spacing, with spring or other device to set blades, vertical face.
 2. Frame: 1-1/4 inch (32 mm) margin with countersunk screw mounting.
 3. Fabrication: Steel frames and blades, with factory baked enamel finish.
 4. Color: As indicated on the drawings.
 5. Color: To be selected by Architect from manufacturer's standard range.
 6. Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face.
 7. Gymnasiums: Provide front pivoted or welded in place blades, securely fastened to be immobile.
- K. Wall and Ceiling Gypsum Board Access Panels with Return Air Grilles
1. Description: Return air grille with full service access. Louvers to be fitted into frameless door flush with drywall surface. Return air grille can be integrated with manufacturer's suggested access panel or installed directly in drywall surface.
 2. Return Air Grille: Linear bar grilles fitted with flush and concealed perimeter grille frame.
 - a. Type: Fixed grille with 1/4 inch (6.4 mm) thick by 5/8 inch (15.9 mm) deep bars at 1/2 inch (12.7 mm) on center providing 48 percent free area.
 - b. Dimensions: 12 by 12 inch (305 by 305 mm) set within 1/2 inch (12.7 mm) thick gypsum board.
 - c. Fabrication: Aluminum with factory powder-coated finish.
 - d. Color: As indicated on drawings.
 - e. Color: To be selected by Architect from manufacturer's standard range.
 - f. Frame: 1 inch (25.4 mm) margin with concealed countersunk screw mounting.
 3. Gypsum Board Access Panels: Provide rectangular access panel with recessed and gasketed aluminum perimeter frame that acts as finishing edge and having concealed mechanical touch-latch with safety cable.
 - a. Panel Frame Size: 24 by 24 inch (610 by 610 mm) set within 1/2 inch (12.7 mm) thick gypsum board.
 - b. Panel Frame Diameter: 24 inch (610 mm) set within 1/2 inch (12.7 mm) thick gypsum board.
 - c. Panel Style: Standard style.
 - d. Panel Frame: 1 inch (25.4 mm) margin with concealed countersunk screw mounting.
- L. Door Grilles
1. Type: V-shaped louvers of 20 gauge, 0.0359 inch (0.91 mm) thick steel, 1 inch (25 mm) deep on 1/2 inch (13 mm) centers.
 2. Frame: 20 gauge, 0.0359 inch (0.91 mm) steel with auxiliary frame to give finished appearance on both sides of door, with factory prime coat finish.

2.02 LOUVERS AND PENTHOUSES

- A. Louvers
1. Type: 4 inch (100 mm) deep frame with blades on 45 degree slope with center baffle and return bend, heavy channel frame, 1/2 inch (13 mm) square mesh screen over intake or exhaust end.
 2. Fabrication: 16 gauge, 0.0598 inch (1.52 mm) thick galvanized steel thick galvanized steel welded assembly, with factory prime coat finish.
 3. Color: As indicated on the drawings.
 4. Mounting: Furnish with interior flat flange for installation.
- B. Industrial Fiberglass Louvers
1. Type: 4 inch (100 mm) deep vinyl-ester resin fiberglass channel frame, thick fiberglass blades aligned at 45 degrees, factory-applied prime coat, and PVC-coated bird screen.
 2. Color: As indicated on the drawings.
 3. Maximum Service Temperature: 200 degrees F (93.3 degrees C).

C. Combination Louvers

1. Damper-combined, drainable louver:
2. Size: As indicated on the drawings.
3. Material: Extruded galvanized steel.
4. Paint Finish and Color: As indicated on the drawings.
5. Rust Inhibitor Coating: Standard.
6. Sleeve or Flange: Factory-mounted standard.
7. Duct Transition Fitting: Round.
8. Linkage: Concealed in frame.
9. Custom Features: Include architectural finish.
10. Insulation: Water-resistant sound absorbing material.
11. Mounting: Furnish with interior flat flange for installation.
12. Hurricane Zone Approved: FLA (PAD) and Miami (APD) listed using impact resistant aluminum material.

D. Roof Hoods

1. Fabricate air inlet or exhaust hoods in accordance with {RS#1954}.
2. Fabricate of galvanized steel, minimum 16 gauge, 0.0598 inch (1.52 mm) base and 20 gauge, 0.0359 inch (0.91 mm) hood, or aluminum, minimum 16 gauge, 0.0598 inch (1.52 mm) base and 18 gauge, 0.0598 inch (1.21 mm) hood; suitably reinforced; with removable hood; birdscreen with 1/2 inch (13 mm) square mesh for exhaust and 3/4 inch (19 mm) for intake, and factory prime coat finish.
3. Fabricate louver penthouses with mitered corners and reinforce with structural angles.
4. Mount unit on minimum 12 inch (300 mm) high curb base with insulation between duct and curb.
5. Make hood outlet area minimum of twice throat area.

E. Goosenecks

1. Fabricate in accordance with of minimum 18 gauge, 0.0598 inch (1.21 mm) galvanized steel.
2. Mount on minimum 12 inch (300 mm) high curb base where size exceeds 9 by 9 inch (230 by 230 mm).

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Comply with SMACNA (ASMM) for flashing/counter-flashing of roof penetrations and supports for roof curbs and roof mounted equipment.
- C. Check location of outlets and inlets and make necessary adjustments in position to comply with architectural features, symmetry, and lighting arrangement.
- D. Install diffusers to ductwork with air tight connection.
- E. Provide balancing dampers on duct take-off to diffusers and grilles and registers, despite whether dampers are specified as part of diffuser, or grille and register assembly.
- F. Paint ductwork visible behind air outlets and inlets matte black, see Section 09 91 23.

END OF SECTION

**SECTION 23 41 00
PARTICULATE AIR FILTRATION**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Metal Panel Filters.
- B. Flat Panel Filters
- C. Pleated Panel Filters.
- D. Ring Panel Filters.
- E. Nonsupported Bag Filters.
- F. Supported Bag Filters.
- G. Rigid Cell Box Filters.
- H. V-Bank Cell Filters.
- I. Self-Supported Pocket Filters.
- J. Automatic Roll Filters.
- K. Bulk Media.
- L. Front and Rear Access Filter Frames.
- M. Side-Service Housing.
- N. Filter Gages.

1.02 GENERAL REFERENCES

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.
- B. Division 20, including all Common Mechanical Requirements in Section 20 00 00, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.

1.03 REFERENCE STANDARDS

- A. 40 CFR 59, Subpart D - National Volatile Organic Compound Emission Standards for Architectural Coatings; U.S. Environmental Protection Agency; Current Edition.
- B. ASHRAE Std 52.1 - Gravimetric and Dust Spot Procedures for Testing Air-Cleaning Devices used in General Ventilation for Removing Particulate Matter; x.
- C. ASHRAE Std 52.2 - Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size; 2025.
- D. ASHRAE Std 62.1 - Ventilation for Acceptable Indoor Air Quality; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- F. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2024.
- G. {RSTEMP#1880}
- H. UL 900 - Standard for Air Filter Units; Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. Action Submittals
 - 1. Product Data: For each type of product indicated. Include dimensions; operating characteristics; required clearances and access; rated flow capacity, including initial and

final pressure drop at rated airflow; efficiency and test method; fire classification; furnished specialties; and accessories for each model indicated.

2. Shop Drawings: For air filters. Include plans, elevations, sections, details, and attachments to other work.
 - a. Show filter rack assembly, dimensions, materials, and methods of assembly of components.
 - b. Include setting drawings, templates, and requirements for installing anchor bolts and anchorages.
 - c. Wiring Diagrams: For power, signal, and control wiring.

B. Operation and Maintenance Materials

C. Record Documents

1.05 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE Compliance:
 1. Comply with applicable requirements in ASHRAE Std 62.1, Section 4 - "Outdoor Air Quality"; Section 5 - "Systems and Equipment"; and Section 7 - "Construction and Startup."
 2. Comply with ASHRAE Std 52.1 for arrestance and ASHRAE Std 52.2 for MERV for methods of testing and rating air-filter units.
- C. Comply with NFPA 90A and {RS#1880}.

1.06 COORDINATION

1.07 EXTRA MATERIALS

PART 2 PRODUCTS

2.01 METAL PANEL FILTERS

- A. Description: Factory-fabricated, self-supported, cleanable, all-metal, impingement-type, panel-type, permanent air filters with holding frames.
- B. Manufacturers:
 1. AFF International.
 2. Camfil Farr.
 3. Flanders Corporation.
 4. Purafil.
- C. Media: Four alternate layers of galvanized-steel flat and herringbone-crimp screen.
 1. Nonoiled for grease removal application.
 2. Adhesive coating.
 - a. Adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - b. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- D. Filter-Media Frame: Galvanized steel, hinged, and with pull and retaining handles fastened to the media.
 1. Drain holes.
- E. Capacities and Characteristics:
 1. Face Area: .
 2. Face Dimensions: .
 3. Thickness or Depth: .
 4. Surface Area: .

5. Holding Frame Size: .
6. Number of Filters: .
7. System Airflow: .
8. Maximum or Rated Face Velocity: .
9. Efficiency: 90 percent on particles 20 micrometers and larger at 500 fpm (2.5 m/s) .
10. Initial Resistance: .
11. Recommended Final Resistance: .

2.02 FLAT PANEL FILTERS

- A. Description: Factory-fabricated, self-supported, flat, nonpleated, panel-type, disposable air filters with holding frames.
- B. Manufacturers:
 1. AFF International.
 2. Camfil Farr.
 3. Flanders Corporation.
 4. Purafil.
- C. Filter Unit Class: UL 900, Class 1.
- D. Media: Interlaced glass or synthetic fibers coated with nonflammable adhesive.
 1. Adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
 3. Media shall be coated with an antimicrobial agent.
 4. Metal Retainer: Upstream side and downstream side.
- E. Filter-Media Frame: Cardboard with perforated metal retainer sealed or bonded to the media.
- F. Mounting Frames: Welded galvanized steel, with gaskets and fasteners; suitable for bolting together into built-up filter banks.
- G. Capacities and Characteristics:
 1. Face Area: .
 2. Face Dimensions: .
 3. Thickness or Depth: .
 4. Surface Area: .
 5. Holding Frame Size: .
 6. Number of Filters: .
 7. System Airflow: .
 8. Maximum or Rated Face Velocity: .
 9. Arrestance: 85 percent when tested according to ASHRAE Std 52.1.
 10. MERV Rating: 6 when tested according to ASHRAE Std 52.2.
 11. Initial Resistance: .
 12. Recommended Final Resistance: .

2.03 PLEATED PANEL FILTERS

- A. Description: Factory-fabricated, self-supported, extended-surface, pleated, panel-type, disposable air filters with holding frames.
- B. Manufacturers:
 1. AFF International.
 2. Camfil Farr.
 3. Flanders Corporation.
 4. Purafil.

- C. Filter Unit Class: UL 900 , Class 1.
- D. Media: Interlaced glass or synthetic fibers coated with nonflammable adhesive.
 - 1. Adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
 - 3. Media shall be coated with an antimicrobial agent.
 - 4. Separators shall be bonded to the media to maintain pleat configuration.
 - 5. Welded wire grid shall be on downstream side to maintain pleat.
 - 6. Media shall be bonded to frame to prevent air bypass.
 - 7. Support members on upstream and downstream sides to maintain pleat spacing.
- E. Filter-Media Frame: Cardboard frame with perforated metal retainer sealed or bonded to the media.
- F. Mounting Frames: Welded galvanized steel, with gaskets and fasteners; suitable for bolting together into built-up filter banks.
- G. Capacities and Characteristics:
 - 1. Face Area: .
 - 2. Face Dimensions: .
 - 3. Thickness or Depth: .
 - 4. Surface Area: .
 - 5. Holding Frame Size: .
 - 6. Number of Filters: .
 - 7. System Airflow: .
 - 8. Maximum or Rated Face Velocity: .
 - 9. Efficiency: 90 percent on particles 20 micrometers and larger at 500 fpm (2.5 m/s) .
 - 10. Arrestance: 85 percent when tested according to ASHRAE Std 52.1.
 - 11. Initial Resistance: 0.25-inch wg (62 Pa) at 350 fpm (1.8 m/s).
 - 12. Recommended Final Resistance: .
 - 13. MERV Rating: 7 when tested according to ASHRAE Std 52.2.

2.04 NONSUPPORTED BAG FILTERS

- A. Description: Factory-fabricated, dry, extended-surface, nonsupported filters with header frames.
- B. Manufacturers:
 - 1. AFF International.
 - 2. Camfil Farr.
 - 3. Flanders Corporation.
 - 4. Purafil.
- C. Filter Unit Class: UL 900 , Class 1.
- D. Media: Glass-fiber material constructed so individual pockets are maintained in tapered form under rated-airflow conditions by flexible internal supports.
 - 1. Media shall be coated with an antimicrobial agent.
- E. Filter-Media Frame: Galvanized steel.
- F. Mounting Frames: Welded galvanized steel, with gaskets and fasteners; suitable for bolting together into built-up filter banks.
- G. Capacities and Characteristics:
 - 1. Face Area: .
 - 2. Face Dimensions: .
 - 3. Thickness or Depth: .

4. Surface Area: .
5. Holding Frame Size: .
6. Number of Filters: .
7. System Airflow: .
8. Maximum or Rated Face Velocity: .
9. Efficiency: 90 percent on particles 20 micrometers and larger at 500 fpm (2.5 m/s) .
10. Arrestance: 55 percent when tested according to ASHRAE Std 52.1.
11. Initial Resistance: .
12. MERV Rating: 8 when tested according to ASHRAE Std 52.2.

2.05 SUPPORTED BAG FILTERS

- A. Description: Factory-fabricated, dry, extended-surface, self-supported filters with holding frames in steel, basket-type retainers.
- B. Manufacturers:
 1. AFF International.
 2. Camfil Farr.
 3. Flanders Corporation.
 4. Purafil.
- C. Filter Unit Class: UL 900, Class 1.
- D. Media: Fibrous material constructed so individual pleats are maintained in tapered form under rated-airflow conditions by flexible internal supports.
 1. Media shall be coated with an antimicrobial agent.
- E. Filter-Media Frame: Galvanized steel.
- F. Mounting Frames: Welded galvanized steel, with gaskets and fasteners; suitable for bolting together into built-up filter banks.
- G. Capacities and Characteristics:
 1. Face Area: .
 2. Face Dimensions: .
 3. Thickness or Depth: .
 4. Surface Area: .
 5. System Airflow: .
 6. Maximum or Rated Face Velocity: .
 7. Arrestance: 85 percent when tested according to ASHRAE Std 52.1.
 8. Initial Resistance: .
 9. Recommended Final Resistance: .
 10. MERV Rating: 6 when tested according to ASHRAE Std 52.2.

2.06 RIGID CELL BOX FILTERS

- A. Description: Factory-fabricated, adhesive-coated, disposable, packaged air filters with media perpendicular to airflow, and with holding frames.
- B. Manufacturers:
 1. AFF International.
 2. Camfil Farr.
 3. Flanders Corporation.
 4. Purafil.
- C. Filter Unit Class: UL 900, Class 1.

- D. Media: Fibrous material constructed so individual pleats are maintained in tapered form under rated-airflow conditions by flexible internal supports.
 - 1. Adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
 - 3. Media shall be coated with an antimicrobial agent.
- E. Filter-Media Frames: Galvanized steel.
- F. Mounting Frames: Welded galvanized steel, with gaskets and fasteners; suitable for bolting together into built-up filter banks.
- G. Capacities and Characteristics:
 - 1. Face Area: .
 - 2. Face Dimensions: .
 - 3. Thickness or Depth: .
 - 4. Surface Area: .
 - 5. System Airflow: .
 - 6. Maximum or Rated Face Velocity: .
 - 7. Arrestance: 85 percent when tested according to ASHRAE Std 52.1.
 - 8. Initial Resistance: .
 - 9. Recommended Final Resistance: .
 - 10. MERV Rating: 6 when tested according to ASHRAE Std 52.2.

2.07 SELF-SUPPORTED POCKET FILTERS

- A. Description: Factory-fabricated, panel-type, disposable air filters with contoured media for extended surface.
- B. Manufacturers:
 - 1. AFF International.
 - 2. Flanders Corporation.
- C. Filter Unit Class: UL 900, Class 1.
- D. Media: Fibrous material constructed so individual pleats are maintained in tapered form under rated-airflow conditions by flexible internal supports.
 - 1. Media shall be coated with an antimicrobial agent.
- E. Configuration: Single-pocket cube.
- F. Filter-Media Frame: Galvanized steel .
- G. Mounting Frames: Welded galvanized steel, with gaskets and fasteners; suitable for bolting together into built-up filter banks.
- H. Capacities and Characteristics:
 - 1. Face Dimensions: .
 - 2. Thickness or Depth: .
 - 3. Surface Area: .
 - 4. System Airflow: .
 - 5. Maximum or Rated Face Velocity: .
 - 6. Arrestance: 85 percent when tested according to ASHRAE Std 52.1.
 - 7. Initial Resistance: .
 - 8. Recommended Final Resistance: .

9. MERV Rating: 6 when tested according to ASHRAE Std 52.2.

2.08 FRONT- AND REAR-ACCESS FILTER FRAMES

- A. Framing System: Galvanized steel framing members with access for either upstream (front) or downstream (rear) filter servicing, cut to size and prepunched for assembly into modules. Vertically support filters to prevent deflection of horizontal members without interfering with either filter installation or operation.
- B. Manufacturers:
 - 1. AFF International.
 - 2. Airguard.
 - 3. Camfil Farr.
 - 4. Flanders Corporation.
 - 5. Purafil.
- C. Prefilters: Incorporate a separate track with spring clips, removable from front or back.
- D. Sealing: Factory-installed, positive-sealing device for each row of filters, to ensure seal between gasketed filter elements and to prevent bypass of unfiltered air.

2.09 SIDE-SERVICE HOUSINGS

- A. Description: Factory-assembled, side-service housings, constructed of galvanized steel with flanges to connect to duct or casing system.
- B. Manufacturers:
 - 1. AFF International.
 - 2. Airguard.
 - 3. Camfil Farr.
 - 4. Flanders Corporation.
 - 5. Purafil.
- C. Prefilters: Integral tracks to accommodate 2-inch- (50-mm-) deep, disposable or washable filters.
- D. Access Doors: Hinged, with continuous gaskets on perimeter and positive-locking devices, and arranged so filter cartridges can be loaded from either access door.
- E. Sealing: Incorporate positive-sealing gasket material on channels to seal top and bottom of filter cartridge frames and to prevent bypass of unfiltered air.

2.10 FILTER GAGES

- A. Manufacturers:
 - 1. Airguard.
 - 2. Dwyer Instruments.
- B. Diaphragm-type gage with dial and pointer in metal case, vent valves, black figures on white background, and front recalibration adjustment.
 - 1. Diameter: 4-1/2 inches (115 mm).
 - 2. Scale Range for Filter Media Having a Recommended Final Resistance of 0.5-Inch wg (125 Pa) or Less: 0- to 0.5-inch wg (0 to 125 Pa) .
 - 3. Scale Range for Filter Media Having a Recommended Final Resistance of 0.5- to 1.0-Inch wg (125 to 250 Pa) or Less: 0- to 1.0-inch wg (0 to 250 Pa) .
 - 4. Scale Range for Filter Media Having a Recommended Final Resistance of 1.0- to 2.0-Inch wg (250 to 500 Pa) or Less: 0- to 2.0-inch wg (0 to 500 Pa) .
 - 5. Scale Range for Filter Media Having a Recommended Final Resistance of 2.0- to 3.0-Inch wg (500 to 750 Pa) or Less: 0- to 3.0-inch wg (0 to 750 Pa).
 - 6. Scale Range for Filter Media Having a Recommended Final Resistance of 3.0- to 4.0-Inch wg (750 to 1000 Pa) or Less: 0- to 4.0-inch wg (0 to 1000 Pa) .

- C. Manometer-Type Filter Gage: Molded plastic, with epoxy-coated aluminum scale and logarithmic-curve tube gage with integral leveling gage, graduated to read from 0- to 3.0-inch wg (0 to 750 Pa), and accurate within 3 percent of the full scale range.
- D. Accessories: Static-pressure tips, tubing, gage connections, and mounting bracket.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Position each filter unit with clearance for normal service and maintenance. Anchor filter holding frames to substrate.
- B. Install filters in position to prevent passage of unfiltered air.
- C. Install filter gage for each filter bank.
- D. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing with new, clean filters.
- E. Install filter-gage, static-pressure taps upstream and downstream from filters. Install filter gages on filter banks with separate static-pressure taps upstream and downstream from filters. Mount filter gages on outside of filter housing or filter plenum in an accessible position. Adjust and level inclined gages.
- F. Coordinate filter installations with duct and air-handling-unit installations.

3.02 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections:
 - 1. Operate automatic roll filters to demonstrate compliance with requirements.
 - 2. Test for leakage of unfiltered air while system is operating.
- D. Air filter will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

3.03 CLEANING

- A. After completing system installation and testing, adjusting, and balancing of air-handling and air-distribution systems, clean filter housings and install new filter media.

END OF SECTION

**SECTION 23 51 00
BREECHINGS, CHIMNEYS, AND STACKS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Listed Chimney Liners.
- B. Listed Type B and BW Vents.
- C. Listed Type L Vents.
- D. Listed Special Gas Vents.
- E. Listed Building-Heating-Appliance Chimneys.
- F. Listed Grease Ducts.
- G. Listed, Refractory-Lined Metal Breechings and Chimneys.
- H. Field-Fabricated Metal Breechings and Chimneys.
- I. Guying and Bracing Materials.

1.02 GENERAL REFERENCES

- A. Contract Documents: Refer to complete set of Contract Documents for requirements that are related to or may affect the work described in this Section.

1.03 REFERENCE STANDARDS

- A. ASME STS-1 - x; x.
- B. ASTM A106/A106M - Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service; 2019a.
- C. ASTM A240/A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications; 2025a.
- D. ASTM A666/A666M - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2024.
- E. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2021a.
- F. NFPA 211 - Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances; 2024.
- G. UL 103 - Factory-Built Chimneys for Residential Type and Building Heating Appliances; Current Edition, Including All Revisions.
- H. UL 441 - Standard for Gas Vents; Current Edition, Including All Revisions.
- I. UL 641 - Type L Low Temperature Venting Systems; Current Edition, Including All Revisions.
- J. UL 959 - Medium Heat Appliance Factory Built Chimneys; Current Edition, Including All Revisions.
- K. UL 1738 - Standard for Venting Systems for Gas-Burning Appliances, Categories II, III, and IV; Current Edition, Including All Revisions.
- L. UL 1777 - Chimney Liners; Current Edition, Including All Revisions.

1.04 DEFINITIONS

- A. Breeching: Vent connector.
- B. Chimney: Primarily vertical shaft enclosing at least one vent for conducting flue gases outdoors.
- C. Smoke Pipe: Round, single wall vent connector.

- D. Vent: That portion of a venting system designed to convey flue gases directly outdoors from a vent connector or from an appliance when a vent connector is not used.
- E. Vent Connector: That part of a venting system that conducts the flue gases from the flue collar of an appliance to a chimney or vent, and may include a draft control device.

1.05 SUBMITTALS

- A. Action Submittals
 - 1. Product Data: Provide data indicating factory built chimneys, including dimensional details of components and flue caps, dimensions and weights, electrical characteristics and connection requirements.
 - 2. Shop Drawings: Indicate general construction, dimensions, weights, support and layout of breechings. Submit layout drawings indicating plan view and elevations where factory-built units are used.
 - 3. Manufacturer's Instructions: Include installation instructions, and indicate assembly, support details, and connection requirements.
 - 4. Manufacturer's Certificate: Certify that refractory lined metal stacks meet or exceed specified requirements.
 - 5. Designer's qualification statement.
 - 6. Manufacturer's qualification statement.
 - 7. Installer's qualification statement.
- B. Operation and Maintenance Materials
- C. Record Documents

1.06 QUALITY ASSURANCE

- A. Designer Qualifications: Design stacks under direct supervision of a Professional Structural Engineer experienced in design of the type of work specified and licensed in the State in which the Project is located.

1.07 COORDINATION

- A. Coordinate the installation of _____ with size, location and installation of service utilities.
- B. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.
- C. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

PART 2 PRODUCTS

2.01 LISTED CHIMNEY LINERS

- A. Manufacturers:
 - 1. American Metal Products.
 - 2. Deflect-O Corp.
 - 3. Heat-Fab.
 - 4. Industrial Chimney Company.
 - 5. Metal-Fab.
 - 6. Selkirk Corporation.
 - 7. Shook Manufactured Products.
 - 8. Simpson Dura-Vent Co.
 - 9. Tru-Flex Metal Hose Corp.
- B. Description: Straight single-wall chimney liner tested according to UL 1777 and rated for 1000 deg F (538 deg C) continuously, or 2100 deg F (1150 deg C) for 10 minutes; with negative or positive flue pressure complying with NFPA 211.
- C. Straight Liner Materials: ASTM A666/A666M, Type 304 stainless steel.

- D. Corrugated Liner Materials: ASTM A240/A240M , Type 321 stainless steel.
- E. Accessories:
 - 1. Fittings: Tees, elbows, increasers, draft-hood connectors, metal caps with bird barriers, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar or compatible materials and designs.
 - 2. Sealant: Manufacturer's standard high-temperature sealant.
 - 3. Insulating Fill: Manufacturer's standard high-temperature insulation fill material in annular space surrounding chimney liner including high-temperature, ceramic-fiber insulation required to seal chimney at top and bottom.

2.02 LISTED TYPE B AND BW VENTS

- A. Manufacturers:
 - 1. American Metal Products.
 - 2. Cleaver-Brooks.
 - 3. Famco.
 - 4. Hart & Cooley.
 - 5. Heat-Fab.
 - 6. Industrial Chimney Company.
 - 7. LSP Products Group.
 - 8. Metal-Fab.
 - 9. Schebler Co.
 - 10. Selkirk Corporation.
 - 11. Simpson Dura-Vent Co.
 - 12. Tru-Flex Metal Hose Corp.
 - 13. Van-Packer Company.
- B. Description: Double-wall metal vents tested according to UL 441 and rated for 480 deg F (248 deg C) continuously for Type B, or 550 deg F (288 deg C) continuously for Type BW; with neutral or negative flue pressure complying with NFPA 211.
- C. Construction: Inner shell and outer jacket separated by at least a 1/4 inch (6 mm) airspace.
- D. Inner Shell: ASTM B209/B209M , Type 3003 aluminum
- E. Outer Jacket: Galvanized steel.
- F. Accessories: Tees, elbows, increasers, draft-hood connectors, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.
 - 1. Termination: Stack cap designed to exclude minimum 90 percent of rainfall.
 - 2. Termination: Round chimney top designed to exclude minimum 98 percent of rainfall.
 - 3. Termination: Exit cone with drain section incorporated into riser.
 - 4. Termination: Antibackdraft.
 - 5. Termination:

2.03 LISTED TYPE L VENTS

- A. Manufacturers:
 - 1. American Metal Products.
 - 2. FAMCO.
 - 3. Heat-Fab.
 - 4. Industrial Chimney Company.
 - 5. LSP Products Group.
 - 6. Metal-Fab.
 - 7. Schebler Co.
 - 8. Selkirk Corporation.

9. Simpson Dura-Vent Co.
 10. Tru-Flex Metal Hose Corp.
 11. Van-Packer Company.
- B. Description: Double-wall metal vents tested according to UL 641 and rated for 570 deg F (300 deg C) continuously, or 1700 deg F (926 deg C) for 10 minutes; with neutral or negative flue pressure complying with NFPA 211.
- C. Construction: Inner shell and outer jacket separated by at least a 1/4-inch (6-mm) airspace filled with high-temperature, ceramic-fiber insulation.
- D. Inner Shell: ASTM A666/A666M, Type 304 stainless steel.
- E. Outer Jacket: Galvanized steel.
- F. Accessories: Tees, elbows, increasers, draft-hood connectors, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.
1. Termination: Stack cap designed to exclude 90 percent of rainfall.
 2. Termination: Round chimney top designed to exclude 98 percent of rainfall.
 3. Termination: Exit cone with drain section incorporated into riser.
 4. Termination:

2.04 LISTED BUILDING HEATING APPLIANCE CHIMNEYS

- A. Manufacturers:
1. American Metal Products.
 2. Cleaver-Brooks.
 3. Famco.
 4. Hart & Cooley.
 5. Heat-Fab.
 6. Industrial Chimney Company.
 7. LSP Products Group.
 8. Metal-Fab.
 9. Schebler Co.
 10. Selkirk Corporation.
 11. Simpson Dura-Vent Co.
 12. Tru-Flex Metal Hose Corp.
 13. Van-Packer Company.
- B. Description: Double-wall metal vents tested according to UL 103 and rated for 1000 deg F (538 deg C) continuously, or 1700 F (926 C) for 10 minutes; with neutral or negative flue pressure complying with NFPA 211.
- C. Construction: Inner shell and outer jacket separated by at least a 1/2-inch (25-mm) annular space filled with high-temperature, ceramic-fiber insulation.
- D. Inner Shell: ASTM A666/A666M, Type 304 stainless steel.
- E. Description: Double-wall metal vents tested according to UL 103 and UL 959 and rated for 1400 F (760 C) continuously, or 1800 F (982 C) for 10 minutes; with positive or negative flue pressure complying with NFPA 211 .
- F. Construction: Inner shell and outer jacket separated by at least a 1-inch (25-mm) annular space filled with high-temperature, ceramic-fiber insulation.
- G. Inner Shell: ASTM A666/A666M, Type 304 stainless steel.
- H. Description: Double-wall metal vents tested according to UL 103 and rated for 1000 deg F (538 deg C) continuously, or 2100 deg F (1150 deg C) for 10 minutes; with neutral or negative flue pressure complying with NFPA 211.

- I. Construction: Inner shell and outer jacket separated by at least a 1-inch (25-mm) annular space filled with high-temperature, ceramic-fiber insulation.
- J. Inner Shell: ASTM A666 , Type 304 stainless steel.
- K. Outer Jacket: Galvanized steel.
- L. Accessories: Tees, elbows, increasers, draft-hood connectors, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.
 - 1. Termination: Stack cap designed to exclude minimum 90 percent of rainfall.
 - 2. Termination: Round chimney top designed to exclude minimum 98 percent of rainfall.
 - 3. Termination: Exit cone with drain section incorporated into riser.
 - 4. Termination:

2.05 LISTED, REFRACTORY-LINED METAL BREECHINGS AND CHIMNEYS

- A. Manufacturers:
 - 1. Van-Packer Company.
 - 2. Warren Environment.
- B. Comply with ASME STS-1.
- C. Design Wind Loads: 150 mph (241 km/h).
- D. Design for seismic conditions at Project site.
- E. Chimney Outer Jacket: Aluminized steel with riveted seams.
- F. Refractory Lining: Tested according to UL 959 for temperature and acid resistance, and bearing the testing laboratory label.
 - 1. Temperature Rating: 1800 deg F (982 deg C) continuously, and 2000 deg F (1093 deg C) intermittently.
 - 2. Acid Extraction: Maximum of 0.2 percent.
 - 3. Cold Crushing Strength: Minimum of 3200 psig (22 MPa).
 - 4. Thickness: Minimum of 2 inch (50 mm).
- G. Finish: Factory-applied, high-heat-resistant paint; color as selected by Architect.
- H. Base Section: Acid-resistant-coated, cast-iron anchor lugs for securing stack to foundation with anchorage designed by manufacturer.
- I. Reinforced Cleanout Section: Smoke-tight connection, with gasketed and bolt-tightened inspection plate; neck shall be welded to stack section.
- J. T or Y Sections: Smoke-tight connection, with welded joints and refractory lining; finished with smooth transition and with no exposed metal on inside.
- K. Spark Screen: ASTM A666/A666M, Type 316 stainless steel, 0.0625 inch (1.6 mm) thick, maximum 1/2-by-1/2-inch (13-by-13-mm) mesh, with ASTM A666/A666M, Type 304 stainless-steel rolled angle and drawband.
- L. Guy Bands: 8 inch (200 mm) wide bands of same material as jacket, with bolted fasteners.
- M. Roof Penetration: Factory-fabricated thimbles, flashings, and counterflashings.
- N. Fabricate sections, fittings, and accessories as individual pieces or in combination lengths for field handling.
- O. Fabricate components with centrifugally cast refractory lining in lengths suitable for connection with drawbands.
- P. Bond refractory to steel jacket with calcium aluminate cement to prevent separation in finished product during shipping, handling, and installation.

- Q. Fabricate stacks with anchor lugs; cleanout; T sections; flashings and counterflashings; and provisions for support, expansion, and contraction.

2.06 GUYING AND BRACING MATERIALS

- A. Cable: Three galvanized, stranded wires of the following thickness:
1. Minimum Size: 1/4 inch (6 mm) in diameter.
 2. For ID Sizes 4 to 15 Inches (100 to 381 mm): 5/16 inch (8 mm).
 3. For ID Sizes 18 to 24 Inches (457 to 610 mm): 3/8 inch (9.5 mm).
 4. For ID Sizes 27 to 30 Inches (685 to 762 mm): 7/16 inch (11 mm).
 5. For ID Sizes 33 to 36 Inches (838 to 915 mm): 1/2 inch (13 mm).
 6. For ID Sizes 39 to 48 Inches (990 to 1220 mm): 9/16 inch (14.3 mm).
 7. For ID Sizes 51 to 60 Inches (1295 to 1524 mm): 5/8 inch (16 mm).
- B. Pipe: Two galvanized steel, NPS 1-1/4 (DN 32).
- C. Angle Iron: Two galvanized steel, 2 by 2 by 0.25 inch (50 by 50 by 6 mm).

PART 3 EXECUTION

3.01 APPLICATION

- A. Listed Chimney Liners: High-efficiency boiler or furnace vents in masonry chimney, dishwasher exhaust, or Type II commercial kitchen hood.
- B. Listed Type B and BW Vents: Vents for certified gas appliances.
- C. Listed Type L Vent: Vents for low-heat appliances.
- D. Listed Special Gas Vent: Condensing gas appliances.
- E. Listed Building-Heating-Appliance Chimneys: Dual-fuel boilers, oven vents, water heaters, and exhaust for engines. Fireplaces and other solid-fuel-burning appliances.
- F. Listed Grease Ducts: Type I commercial kitchen grease duct.
- G. Listed, Refractory-Lined Metal Breechings and Chimneys: Freestanding dual-fuel boiler vents, oven vents, water heaters, exhaust for engines, fireplaces, and other solid-fuel-burning appliances.
- H. Field-Fabricated Metal Breechings and Chimneys: Dual-fuel boilers, oven vents, water heaters, exhaust for engines, fireplaces, and other solid-fuel-burning appliances.
- I. Field-Fabricated Metal Breechings and Chimneys: Steel pipe for use with engine exhaust.

3.02 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of work.
1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.03 INSTALLATION

- A. Listed Vents and Chimneys
1. Locate to comply with minimum clearances from combustibles and minimum termination heights according to product listing or NFPA 211, whichever is most stringent.
 2. Seal between sections of positive-pressure vents and grease exhaust ducts according to manufacturer's written installation instructions, using sealants recommended by manufacturer.
 3. Support vents at intervals recommended by manufacturer to support weight of vents and all accessories, without exceeding appliance loading.
 4. Slope breechings down in direction of appliance, with condensate drain connection at lowest point piped to nearest drain. Slope grease ducts at a minimum of 2% back in direction of the grease hood or toward an approved grease reservoir. Where horizontal ducts exceed 75 feet in length, the slope shall not be less than 8.3%.

5. Provide listed and labeled grease duct cleanouts with tight fitting doors constructed of steel having thickness not less than that required for the duct, on horizontal sections of grease ducts not more than 20 ft. apart. Install per the manufacturers listing requirements and local code requirements.
6. Lap joints in direction of flow.
7. Connect base section to foundation using anchor lugs of size and number recommended by manufacturer.
8. Join sections with acid-resistant joint cement to provide continuous joint and smooth interior finish.
9. Erect stacks plumb to finished tolerance of no more than 1 inch (25 mm) out of plumb from top to bottom.
10. Terminate grease ducts not less than 40 inches above the roof surface.
11. Suspend breechings and chimneys independent of their appliance connections.
12. Install, support, and restrain according to seismic requirements.
13. Align breechings at connections, with smooth internal surface and a maximum 1/8 inch (3 mm) misalignment tolerance.
14. Slope breechings down in direction of appliance, with condensate drain connection at lowest point piped to nearest drain.
15. Lap joints in direction of flow.
16. Support breechings and chimneys from building structure with bolts, concrete inserts, steel expansion anchors, welded studs, C-clamps, or beam clamps according to manufacturer's written instructions.

3.04 CLEANING

- A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.
- B. Clean breechings internally, during and after installation, to remove dust and debris. Clean external surfaces to remove welding slag and mill film. Grind welds smooth and apply touchup finish to match factory or shop finish.
- C. Provide temporary closures at ends of breechings, chimneys, and stacks that are not completed or connected to equipment.

END OF SECTION

**SECTION 23 51 23
GAS VENTS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Listed Type B And BW Vents
 - 1. Description
 - 2. Construction
 - 3. Inner Shell
 - 4. Outer Jacket
 - 5. Accessories
- B. Listed Type L Vents
 - 1. Description
 - 2. Construction
 - 3. Inner Shell
 - 4. Outer Jacket
 - 5. Accessories
- C. Listed Special Gas Vents
 - 1. Description
 - 2. Construction
 - 3. Inner Shell
 - 4. Outer Jacket
 - 5. Accessories

1.02 GENERAL REFERENCES

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Contract Documents: Refer to complete set of Contract Documents for requirements that are related to or may affect the work described in this Section.

1.03 RELATED REQUIREMENTS

- A. Section 235113.11 "Draft Control Fans" for draft inducer fans, venturi-draft inducer fans, mechanical-draft vent fans, vent exhaust fans, and combustion-air fans.
- B. Section 235113.16 "Vent Dampers" for motorized and barometric dampers.
- C. Section 235116 "Fabricated Breechings and Accessories" for listed, refractory-lined metal breechings and field-fabricated metal breechings.
- D. Section 235133 "Insulated Sectional Chimneys" for listed chimney liners; listed building-heating-appliance chimneys; listed, refractory-lined metal chimneys; and field-fabricated chimneys.

1.04 REFERENCE STANDARDS

1.05 ABBREVIATIONS AND ACRONYMS

1.06 DEFINITIONS

1.07 PERFORMANCE REQUIREMENTS

1.08 SUBMITTALS

- A. Action Submittals
 - 1. Product Data: For each type of product.
 - a. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for product.
 - 2. Shop Drawings: For vents.

- a. Include plans, elevations, sections, and attachment details.
- b. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
- c. Detail fabrication and assembly of hangers and seismic restraints.
3. Required Embodied Carbon Submittals: All products which satisfy one of the following criteria will require an Embodied Carbon Submittal:
 - a. The product is a 'Major' piece of equipment
 - b. The product contains refrigerant
 - c. The cost of a group of products serving a given function constitutes 5% or greater of the sub-contractor's budget, excluding labor.
4. Embodied Carbon Submittals
 - a. Order of Preferred Submittals: For products which require an embodied carbon submittal (described above), one of the following must be provided. The submittal must be that with the highest preference available. The order preference, from highest to lowest is:
 - 1) Product Specific, Facility Specific EPD
 - 2) Product Specific EPD
 - 3) Industry Average EPD
 - 4) TM65 Manufacturer Form with Mid-Level Calculation data
 - 5) TM65 Manufacturer Form with Basic Calculation data
- B. Informational Submittals
 1. Welding certificates.
 2. Sample Warranty: For special warranty.
- C. Closeout Submittals
- D. LEED Submittals
- E. Operation and Maintenance Materials
- F. Record Documents

1.09 WARRANTIES

1.10 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to the following:
 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
 2. AWS D9.1/D9.1M, "Sheet Metal Welding Code," for shop and field welding of joints and seams in vents.
- B. Certified Sizing Calculations: Manufacturer shall certify venting system sizing calculations.

1.11 PRE-INSTALLATION TESTING

1.12 MOCK-UPS AND SAMPLES

1.13 COORDINATION

1.14 DELIVERY, STORAGE AND HANDLING

1.15 EXTRA MATERIALS

1.16 SUMMARY DESCRIPTION

PART 2 PRODUCTS

2.01 LISTED TYPE B AND BW VENTS

- A. Description: Double-wall metal vents tested according to UL 441 and rated for 480 deg F (248 deg C) continuously for Type B or 550 deg F (288 deg C) continuously for Type BW; with neutral or negative flue pressure complying with NFPA 211.

- B. Construction: Inner shell and outer jacket separated by at least a 1/4-inch (6-mm) airspace.
- C. Inner Shell: ASTM B 209 (ASTM B 209M), Type 1100 aluminum.
- D. Outer Jacket: Galvanized steel.
- E. Accessories: Tees, elbows, increasers, draft-hood connectors, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.
 - 1. Termination: Stack cap designed to exclude minimum 90 percent of rainfall.
 - 2. Termination: Round chimney top designed to exclude minimum 98 percent of rainfall.
 - 3. Termination: Exit cone with drain section incorporated into riser.
 - 4. Termination: Antibackdraft.
 - 5. Termination: _____.

2.02 LISTED TYPE L VENTS

- A. Description: Double-wall metal vents tested according to UL 641 and rated for 570 deg F (300 deg C) continuously or 1700 deg F (926 deg C) for 10 minutes; with neutral or negative flue pressure complying with NFPA 211.
- B. Construction: Inner shell and outer jacket separated by at least a 1/4-inch (6-mm) airspace filled with high-temperature, ceramic-fiber insulation.
- C. Inner Shell: ASTM A 666, Type 304 stainless steel.
- D. Outer Jacket: Galvanized steel.
- E. Accessories: Tees, elbows, increasers, draft-hood connectors, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.
 - 1. Termination: Stack cap designed to exclude 90 percent of rainfall.
 - 2. Termination: Round chimney top designed to exclude 98 percent of rainfall.
 - 3. Termination: Exit cone with drain section incorporated into riser.
 - 4. Termination: _____.

2.03 LISTED SPECIAL GAS VENTS

- A. Description: Double-wall metal vents tested according to UL 1738 and rated for 480 deg F (248 deg C) continuously, with positive or negative flue pressure complying with NFPA 211.
- B. Construction: Inner shell and outer jacket separated by at least a 1/2 inch (13 mm) airspace.
- C. Inner Shell: ASTM A959, Type 29-4C stainless steel.
- D. Outer Jacket: Aluminized steel.
- E. Accessories: Tees, elbows, increasers, draft-hood connectors, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.
 - 1. Termination: Stack cap designed to exclude minimum 90 percent of rainfall.
 - 2. Termination: Round chimney top designed to exclude minimum 98 percent of rainfall.
 - 3. Termination: Exit cone with drain section incorporated into riser.
 - 4. Termination: _____.

PART 3 EXECUTION

3.01 APPLICATION

- A. Listed Type B and BW Vents: Vents for certified gas appliances.
- B. Listed Type L Vent: Vents for low-heat appliances.

- C. Listed Special Gas Vent: Condensing gas appliances.

3.02 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.03 PREPARATION

3.04 INSTALLATION

- A. Installation of Listed Vents
1. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 077200 "Roof Accessories."
 2. Comply with minimum clearances from combustibles and minimum termination heights according to product listing or NFPA 211, whichever is most stringent.
 3. Seal between sections of positive-pressure vents according to manufacturer's written installation instructions, using sealants recommended by manufacturer.
 4. Support vents at intervals recommended by manufacturer to support weight of vents and all accessories, without exceeding appliance loading.
 5. Lap joints in direction of flow.

3.05 CONNECTIONS

- A. Piping Connections
- B. Duct Connections
- C. Electrical Connections
- D. Control Connections

3.06 FIELD QUALITY CONTROL

3.07 START UP SERVICE

3.08 FIELD TESTING

3.09 PAINTING

3.10 IDENTIFICATION

3.11 ADJUSTING

3.12 CLEANING

- A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes.

3.13 DEMONSTRATION AND TRAINING

END OF SECTION

**SECTION 23 52 16
CONDENSING BOILERS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Fire-Tube Condensing Boilers.
- B. Water-Tube Condensing Boilers.
- C. Venting Kits.
- D. Condensate-Neutralization Units.

1.02 GENERAL REFERENCES

- A. Contract Documents: Refer to complete set of Contract Documents for requirements that are related to or may affect the work described in this Section.
- B. Division 20, including all Common Mechanical Requirements in Section 20 00 00, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.

1.03 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-in-Place Concrete.
- B. Section 23 09 13 - Instrumentation and Control Devices for HVAC.
- C. Section 23 21 14 - Hydronic Specialties.
- D. Section 23 21 23 - Hydronic Pumps.
- E. Section 23 25 00 - HVAC Water Treatment.
- F. Section 23 51 00 - Breechings, Chimneys, and Stacks.
- G. Section 26 05 83 - Wiring Connections: Electrical characteristics and wiring connections.

1.04 REFERENCE STANDARDS

- A. AHRI 1500 (I-P) - Performance Rating of Commercial Space Heating Boilers; 2024.
- B. ANSI B31.1 - Power Piping; 2024.
- C. ANSI B31.9 - Building Services Piping; 2025.
- D. {RSTEMP#278}ANSI Z21.13 - American National Standard for Gas-Fired Low-Pressure Steam and Hot Water Boilers{CH#173437}.
- E. {RSTEMP#396}
- F. ASTM A959 - Standard Guide for Specifying Harmonized Standard Grade Compositions for Wrought Stainless Steels; 2019.
- G. CSA 4.9 - x; x.
- H. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.
- I. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.
- J. NFPA 54 - National Fuel Gas Code; 2024.
- K. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- L. {RSTEMP#2159}
- M. UL 795 - Commercial-Industrial Gas Heating Equipment; Current Edition, Including All Revisions.
- N. UL 2764 - x; x.

1.05 SUBMITTALS

1. Product Data: Provide data indicating general assembly, components, controls, safety controls, and wiring diagrams with electrical characteristics and connection requirements, and service connections.
 2. Manufacturer's Installation Instructions: Indicate assembly, support details, connection requirements, and include start up instructions.
 - a. Indicate compliance with specified performance and efficiency.
 - b. Provide results of the following combustion tests:
 - 1) Boiler firing rate.
 - 2) Over fire draft.
 - 3) Gas flow rate.
 - 4) Heat input.
 - 5) Burner manifold gas pressure.
 - 6) Percent carbon monoxide.
 - 7) Percent oxides of nitrogen.
 - 8) Percent oxygen.
 - 9) Percent excess air.
 - 10) Flue gas temperature at outlet.
 - 11) Ambient temperature.
 - 12) Net stack temperature.
 - 13) Percent stack loss.
 - 14) Percent combustion efficiency.
 - 15) Heat output.
 3. Include manufacturer's descriptive literature, operating instructions, cleaning procedures, replacement parts list, and maintenance and repair data.
- B. Provide a five year warranty to include coverage for heat exchanger.
- C. Manufacturer's Factory Inspection Report: Submit boiler inspection prior to shipment.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Protect boilers from damage by leaving factory inspection openings and shipping packaging in place until final installation.

1.07 GENERAL

- A. Trim for Hot-Water Boilers
1. Include devices sized to comply with ANSI B31.1, "Power Piping."
 2. Include devices sized to comply with ANSI B31.9, "Building Services Piping."
 3. Aquastat Controllers: Operating, firing rate, and high limit with manual reset.
 4. Safety Relief Valve: ASME rated.
 5. High and low gas-pressure switches.
 6. Alarm bell with silence switch.
 7. Boiler Air Vent: Automatic.
 8. Drain Valve: Minimum 3/4 (DN 20) hose-end gate valve.
 9. Circulation Pump: Non-overloading, in-line pump with split-capacitor motor having thermal-overload protection and lubricated bearings; designed to operate at specified boiler pressures and temperatures.
- B. Controls
1. Boiler operating controls shall include the following devices and features:
 - a. Control transformer.
 - b. Set-Point Adjust: Set points shall be adjustable.
 - c. Electric, factory-fabricated and factory-installed panel to modulate burner and control burner-firing rate to maintain space temperature in response to thermostat with heat anticipator located in heated space.

- 1) Include automatic, alternating-firing sequence for multiple boilers to ensure maximum system efficiency throughout the load range and to provide equal runtime for boilers.
 - d. Electric, factory-fabricated and factory-installed panel to control burner-firing rate, to reset supply-water temperature inversely with outside-air temperature. Reset information to be provided by the building control system or a outside-air temperature sensor provided by the boiler manufacturer. Coordinate requirements with Division 23 Section 23 09 00 "Instrumentation and Control for HVAC."
 - 1) Include automatic, alternating-firing sequence for multiple boilers to ensure maximum system efficiency throughout the load range and to provide equal runtime for boilers.
 2. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation.
 - a. High Cutoff: Manual reset stops burner if operating conditions rise above maximum boiler design temperature.
 - b. Low-Water Cutoff Switch: Electronic probe shall prevent burner operation on low water. Cutoff switch shall be manual-reset type.
 - c. Blocked Inlet Safety Switch: Manual-reset pressure switch factory mounted on boiler combustion-air inlet.
 - d. Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for above conditions.
 3. Building Automation System Interface: Factory install hardware and software to enable building automation system to monitor, control, and display boiler status and alarms.
 - a. Hardwired Points:
 - 1) Monitoring: On/off status, common trouble alarm, low water level alarm.
 - 2) Control: On/off operation, hot water supply temperature set-point adjustment.
 - b. A BACnet communication interface with building automation system shall enable building automation system operator to remotely control and monitor the boiler from an operator workstation. All monitoring and control features, which are available at the local boiler control panel, shall also be available at the remote operator workstation through the building automation system.
 4. Primary loop control: Provide all communication wiring and devices for primary loop control as depicted on control drawings.
- C. Electrical Power
1. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are shown on Drawings and specified in electrical Sections.
 2. Single-Point Field Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.
 - a. House in NEMA EN 10250, Type 1 enclosure.
 - b. Wiring shall be numbered and color-coded to match wiring diagram.
 - c. Install factory wiring outside of an enclosure in a metal raceway.
 - d. Field power interface shall be to wire lugs.
 - e. Provide branch power circuit to each motor and to controls with a disconnect switch or circuit breaker.
 - f. Provide each motor with overcurrent protection.
- D. Source Quality Control
1. UL Compliance: Test gas-fired boilers having input of more than 400,000 Btu/h (117 kW) for compliance with UL 795. Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

2. UL Compliance, Oil-Fired: Test oil-fired boilers for compliance with {RS#2159}. Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.
3. UL Compliance, Gas-Fired: Test gas-fired boilers for compliance with UL 2764. Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.
4. CSA Compliance: Test boilers for compliance with {RS#278}/CSA 4.9.
5. Performance Testing: Test and label boilers for efficiency to comply with AHRI 1500 (I-P).
6. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.
7. Test and inspect factory-assembled boilers, before shipping, in accordance with 2017 {RS#396}. Factory test boilers for safety and functionality; fill boiler with water, and fire throughout firing range, to prove operation of all safety components.
8. Allow Owner access to source quality-control testing of boilers. Notify Architect 14 days in advance of testing.

1.08 FIRE-TUBE CONDENSING BOILERS

- A. Manufacturers:
 1. AERCO Benchmark.
 2. Cleaver Brooks Clearfire-CE.
 3. Lochinvar Crest.
 4. Lochinvar FTXL.
- B. Description: Factory-fabricated, -assembled, and -tested, fire-tube condensing boiler with heat exchanger sealed pressure tight, built on a steel base, including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls. Units are to be for water-heating service only.
- C. Primary Heat Exchanger: Corrosion-resistant Type 316 stainless steel.
- D. Secondary Heat Exchanger: Corrosion-resistant Type 316 stainless steel.
- E. Combustion Chamber and Flue Pipes: Corrosion-resistant stainless steel.
- F. Combustion Chamber and Flue Pipes: Corrosion-resistant aluminum.
- G. Pressure Vessel: Carbon steel with welded heads and tube connections.
- H. Burner: Natural gas, forced draft.
- I. Blower: Centrifugal fan to operate during each burner firing sequence and to pre-purge and post-purge the combustion chamber.
 1. Motors: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Division 20 Section 20 05 13 "Common Motor Requirements for Mechanical Equipment."
 - a. Motor Sizes: Minimum size as indicated; if not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
- J. Gas Train: Combination gas valve with manual shutoff and pressure regulator.
- K. Ignition: Direct-spark ignition or silicone carbide hot-surface ignition with 100 percent main-valve shutoff and electronic flame supervision.
- L. Casing:
 1. Jacket: Factory painted sheet metal, with snap-in or interlocking closures.
 2. Control Compartment Enclosures: NEMA EN 10250 .
 3. Insulation: Minimum 2-inch- (50-mm-) thick, mineral-fiber insulation surrounding the heat exchanger.
 4. Combustion-Air Connections: Inlet and vent duct collars.

- a. Motor Sizes: Minimum size as indicated; if not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

1.09 WATER-TUBE CONDENSING BOILERS

- A. Manufacturers:
 - 1. Advanced Thermal Hydronics.
 - 2. AERCO.
 - 3. Bosch Thermotechnologies.
 - 4. Bryan.
 - 5. Cleaver Brooks.
 - 6. Embassy Industries.
 - 7. Gasmaster Industries.
 - 8. Heat Transfer Products.
 - 9. Laars.
 - 10. Lochinvar.
 - 11. Raypak.
 - 12. Smith,
 - 13. Triangle Tube.
 - 14. Viessmann.
- B. Description: Factory-fabricated, -assembled, and -tested, copper-finned, water-tube condensing boiler with heat exchanger sealed pressure tight, built on a steel base, including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls. Units are to be for water-heating service only.
- C. Heat Exchanger: Stainless steel primary and secondary heat exchangers.
- D. Combustion Chamber: Stainless steel, sealed.
- E. Burner: Natural gas, forced draft drawing from gas premixing valve.
- F. Blower: Centrifugal fan to operate during each burner firing sequence and to prepurge and postpurge the combustion chamber.
 - 1. Motors: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Division 20 Section 20 05 13 "Common Motor Requirements for Mechanical Equipment."
 - a. Motor Sizes: Minimum size as indicated; if not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
- G. Gas Train: Combination gas valve with manual shutoff and pressure regulator.
- H. Ignition: Direct-spark ignition or silicone carbide hot-surface ignition with 100 percent main-valve shutoff and electronic flame supervision.
- I. Integral Circulator: Cast-iron body and stainless-steel impeller sized for minimum flow required in heat exchanger.
- J. Casing:
 - 1. Jacket: Sheet metal, with snap-in or interlocking closures.
 - 2. Control Compartment Enclosures: NEMA EN 10250 .
 - 3. Finish: Baked-enamel protective finish.
 - 4. Insulation: Minimum 1-inch- (25-mm-) thick, mineral-fiber insulation surrounding the heat exchanger.
 - 5. Combustion-Air Connections: Inlet and vent duct collars.

1.10 VENTING KITS

- A. Refer to Division 23 Section 23 51 00 "Breechings, Chimneys, and Stacks."
- B. Kit: Complete system, ASTM A959, Type AL29-4C stainless steel, pipe, vent terminal, thimble, indoor plate, vent adapter, condensate trap and dilution tank, and sealant.

- C. Combustion-Air Intake: Complete system, stainless steel, pipe, vent terminal with screen, inlet air coupling, and sealant.

1.11 CONDENSATE-NEUTRALIZATION UNITS

- A. Manufacturers:
1. Neutra-Safe Corporation.
 2. SFA Saniflo USA.
 3. Skidmore Pump.
 4. Wessels Company.
- B. Description: Factory-fabricated and -assembled condensate-neutralizing capsule or tank assembly of corrosion-resistant plastic material with threaded or flanged inlet and outlet pipe connections. Device functions to prevent acidic condensate from damaging drain system. It is to be piped to receive acidic condensate discharged from condensing boiler and neutralize it by chemical reaction with replaceable neutralizing agent. Neutralized condensate is then piped to suitable drain.
- C. Capsule or Tank features:
1. All corrosion-resistant material.
 2. Suitable for use on all natural gas and propane boilers.
 3. Includes initial charge of neutralizing agent.
 4. Neutralizing agent to be easily replaceable when exhausted.
 5. Inlet and outlet pipe connections.
- D. Capsule Configuration:
1. Low-profile design for applications where boiler condensate drain is close to the floor.
 2. Easily removed and opened for neutralizing agent replacement.
 3. Multiple units may be used for larger capacity.
- E. Tank Configuration:
1. Utilized where boiler is elevated or where tank is installed in a pit with tank top flush with floor.
 2. Top easily removed for neutralizing agent replacement.
 3. Internal baffles to channel flow for complete neutralization.
 4. Integral bypass to prevent condensate backflow into appliance.
 5. Multiple units may be used for larger capacity.
- F. Examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting performance of the Work.
1. Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.
- G. Examine mechanical spaces for suitable conditions where boilers will be installed.
- H. Proceed with installation only after unsatisfactory conditions have been corrected.
1. Equipment Mounting:
 - a. Install wall-hung boilers where indicated on Drawings using suitable hangers. Comply with manufacturer's mounting instructions.
 2. Install gas-fired boilers according to NFPA 54.
 3. Assemble and install boiler trim.
 4. Install electrical devices furnished with boiler but not specified to be factory mounted.
 5. Install control wiring to field-mounted electrical devices.
 6. Comply with requirements for hydronic piping specified in Division 23 Section 23 21 13 "Hydronic Piping."
 7. Drawings indicate general arrangement of piping, fittings, and specialties.

8. When installing piping adjacent to boiler, allow space for service and maintenance of condensing boilers. Arrange piping for easy removal of condensing boilers.
9. Install condensate drain piping to condensate-neutralization unit and from neutralization unit to nearest floor drain. Piping shall be at least full size of connection. Install piping with a minimum of 2 percent downward slope in direction of flow. Include any vent drains.
10. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of gas-train connection. Provide a reducer if required.
11. Connect hot-water piping to supply- and return-boiler tapplings with shutoff valve, and union or flange at each connection.
12. Install piping from safety relief valves to nearest floor drain.
13. Boiler Venting:
 - a. Comply with all boiler manufacturer's installation instructions.
 - b. Field fabricate and install boiler vent and combustion-air intake.
14. Refer to Division 23 Section 23 51 00 "Breechings, Chimneys, and Stacks."
 - a. Install flue-venting kit and combustion-air intake.
15. Connect wiring according to Division 26 Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
16. Ground equipment according to Division 26 Section 26 05 26 "Grounding and Bonding for Electrical Systems."
 - a. Owner training shall be held at Project site.
17. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.
18. Install control and electrical power wiring to field-mounted control devices.
19. Connect control wiring in accordance with Division 26 Section 26 05 23 "Control-Voltage Electrical Power Cables."

1.12 FIELD QUALITY CONTROL

- A. Testing Agency, Owner: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency, Contractor: Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform tests and inspections with the assistance of a factory-authorized service representative:
- E. Tests and Inspections:
 1. Perform installation and startup checks according to manufacturer's written instructions.
 2. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
 3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level, and water temperature.
 - b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- F. Boiler will be considered defective if it does not pass tests and inspections.
- G. Prepare test and inspection reports.
- H. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

1.13 FIELD TESTING

- A. Manufacturer's Field Reports: Burner manifold gas pressure, percent carbon monoxide (CO), percent oxygen (O), percent excess air, flue gas temperature at outlet, ambient temperature, net stack temperature, percent stack loss, percent combustion efficiency, and heat output.

1.14 DEMONSTRATION AND TRAINING

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain boilers. Refer to Division 01 Section 01 79 00 "Demonstration and Training." Video record the training sessions and provide electronic copy to Owner.
 - 1. Instructor shall be factory trained and certified.
 - 2. Provide not less than two hours of training.
 - 3. Train personnel in operation and maintenance and to obtain maximum efficiency in plant operation.
 - 4. Provide instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.
 - 5. Obtain Owner sign-off that training is complete.

END OF SECTION

SECTION 23 73 13
INDOOR, SEMI-CUSTOM AIR-HANDLING UNITS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Indoor, Semi-custom Air-handling Unit Manufacturers
 - 1. Manufacturers
 - 2. Unit Casings
 - 3. Frame
 - 4. Base Rail
 - 5. Casing Joints
 - 6. Outside Casing Wall
 - 7. Inside Casing Wall
 - 8. Floor Plate
 - 9. Airstream Surfaces
 - 10. Casing Insulation
 - 11. Panels, Doors, and Windows
 - 12. Condensate Drain Pans
- B. Fan, Drive, and Motor Section
 - 1. Fan and Drive Assemblies
 - 2. Plenum Fan Housings
 - 3. Plenum Fan Arrays
 - 4. Fan Shaft Bearings
 - 5. Belt Drives
 - 6. Discharge Dampers
 - 7. Internal Vibration Isolation
 - 8. Motor
 - 9. Variable-Frequency Motor Controller
- C. Coil Section
 - 1. General Requirements for Coil
 - 2. Direct expansion (DX) cooling coil
 - 3. Hydronic heating coil
- D. Air Filtration Section
 - 1. Particulate air filtration is specified in Section 23 41 00 "Particulate Air Filtration."
 - 2. High-efficiency particulate air (HEPA) filtration is specified in Section 23 41 33 "High-Efficiency Particulate Air Filtration."
 - 3. Front-Access Filter Mounting Frames
 - 4. Side-Access Filter Mounting Frames
- E. Dampers
 - 1. General Requirements for Dampers
 - 2. Damper Operators
 - 3. Face-and-Bypass Dampers
 - 4. Outdoor- and Return-Air Dampers
 - 5. Mixing Section
 - 6. Combination Filter and Mixing Section
- F. Sound Attenuators
 - 1. General Requirements
 - 2. Shape
 - 3. Rectangular Silencer Outer Casing
 - 4. Round Silencer Outer Casing

- 5. Inner Casing and Baffles
- 6. Principal Sound-Absorbing Mechanism
- G. Air-to-Air Energy Recovery
 - 1. Heat Wheels
- H. Materials
 - 1. Steel
 - 2. Stainless Steel
 - 3. Galvanized Steel
 - 4. Aluminum
- I. Source Quality Control
 - 1. AHRI 430 Certification
 - 2. AHRI 1060 Certification
 - 3. AMCA 301 or AHRI 260
 - 4. Fan Sound-Power Level Ratings
 - 5. Fan Performance Rating
 - 6. Water Coils
 - 7. Refrigerant Coils

1.02 REFERENCE STANDARDS

- A. AHRI 260 I-P - Sound Rating of Ducted Air Moving and Conditioning Equipment.
- B. AHRI 410 - Forced Circulation Air-Cooling and Air-Heating Coils
- C. AHRI 430 I-P - Performance Rating of Central Station Air Handling Unit Supply Fan
- D. AHRI 1060 I-P - Performance Rating of Air-to-Air Exchangers for Energy Recovery Ventilation Equipment.
- E. AHRI 1210 - Performance Rating of Variable Frequency Drives
- F. AMBA STD 11 - Load Ratings and Fatigue Life for Roller bearings.
- G. AMCA 210 - Laboratory Methods of Testing Fans for Aerodynamic Performance Rating; Air Movement and Control Association international, Inc.
- H. AMCA (DIR) - Directory of Certified Products Licensed Under AMCA International Certified Ratings Program.
- I. AMCA 300 - Reverberant Room Methods of Testing of Fans.
- J. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
- K. AFBMA 9-90 - Load Ratings and Fatigue Life for Ball Bearings
- L. ASHRAE Std 135 - A Data Communication Protocol for Building Automation and Control Networks
- M. ASTM B117 - Salt Spray (Fog Testing)
- N. ASTM C1071 - Thermal and Acoustical Insulation (Mineral Fibre, Duct Lining Material)
- O. ASTM E84 - Surface Burning Characteristics of Building Materials.
- P. NEMA MG 0001 - Motors and Generators
- Q. NFPA 70 - National Electrical Code
- R. NFPA 90A - Installation of Air Conditioning and Ventilation Systems
- S. Units with factory wiring to be UL/ETL/CSA approved and labeled.
- T. Filter media to be UC listed
- U. AMCA 99 - 1401-66 Operating Limits for Central Station Air Handlers.

1.03 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Casing panels shall be self-supporting and capable of withstanding +/- 8-inches of w.g. pressure, without panel joints exceeding a deflection of L/240 where "L" is the unsupported span length within completed casings.
- B. Casing Leakage Performance: ASHRAE 111, Class 6 leakage or better at plus or minus 8 inches wg (2000 Pa).

1.04 SUBMITTALS

- A. Action Submittals
 - 1. Product Data: For each air-handling unit.
 - a. Unit dimensions and weight.
 - b. Cabinet material, metal thickness, finishes, insulation, and accessories.
 - c. Fans:
 - 1) Certified fan-performance curves with system operating conditions indicated.
 - 2) Certified fan-sound power ratings.
 - 3) Fan construction and accessories.
 - 4) Motor ratings, electrical characteristics, and motor accessories.
 - d. Certified coil-performance ratings with system operating conditions indicated.
 - 1) Refrigeration Coil: Computer selection data for coils indicating heating/cooling capacity, refrigerant type and charge, air pressure drop, and refrigerant leak detector with matched outdoor unit. Suction and Liquid connections and refrigerant pipe size.
 - 2) Water Coils: Computer selection data for each coil bank indicating entering/leaving air conditions, entering/leaving fluid conditions, heating/cooling capacity, fluid flow, face velocity, air pressure drop, fluid pressure drop and circuiting. Coil selection corrected for elevation and glycol content if applicable.
 - e. Dampers, including housings, linkages, and operators.
 - f. Filters with performance characteristics.
 - g. Sound Power Level Data: Fan outlet and casing radiation at rated capacity.
 - h. Heat Wheel
 - i. Sustainable Design Documentation: Submit manufacturer's product data on refrigerant used, showing compliance with specified requirements.
 - j. Electrical Requirements: Power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring.
 - 2. Shop Drawings: Indicate assembly, unit dimension, weight loading, required clearances, construction details, field connection details, and electrical characteristics and connection requirements.
 - 3. Samples: Submit two of each type of replacement filter media with frame.
- B. Informational Submittals
 - 1. Source quality-control reports.
 - 2. Field quality-control reports.
- C. Closeout Submittals
 - 1. Operation and Maintenance Data: For air-handling units to include operation, and maintenance manuals.
 - a. Maintenance Data: Include instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists, accessories listed in this specification, and wiring diagrams.
 - 2. Certificates: Certify that coil capacities, pressure drops and selection procedures meet or exceed specified requirements.

1.05 WARRANTIES

- A. Warranty: Manufacturer agrees to repair or replace components of indoor, semi-custom air-handling units that fail in materials or workmanship within specified warranty period.

1. Warranty Period: One year from date of Substantial Completion.
2. Refrigeration Compressor: Five years from date of substantial completion.

1.06 QUALITY ASSURANCE

- A. Quality assurance as required by Section 20 00 00, general mechanical requirements.
- B. Manufacturer Qualification: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
- C. In addition, meet the following:
 1. Certification: Certify air-handling units in accordance with AHRI 430 I-P.
 2. Heating, Cooling, and Air Handling Capacity and Performance Standards: AHRI 430 I-P, AHRI 410, ASHRAE 51, and AMCA 210.
 3. Performance Criteria:
 - a. Provide fans and motors capable for stable operation at design conditions for the cubic feet per minute and 110 percent pressure.
 - b. Select fan operating point at right hand side of peak static pressure point and near the peak of static efficiency.
 - c. Operating Limits: AMCA 99-1401-66.
 4. Provide unit constructed by a manufacturer who has been manufacturing air handling units at least ten years.
 5. Ship units in one piece where possible and in shrink wrapping to protect the unit from dirt, moisture, and/or road salt. Shipping splits can be provided for installation. Provide lifting lugs on each slide of the split to facilitate rigging and joining and joining of segments.
- D. Coordinate sizes and locations of concrete bases with actual equipment provided.
- E. Coordinate sizes and locations of structural-steel support members, if any, with actual equipment provided.
- F. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Filters: One set(s) of each filter type for each air-handling unit.
 2. Gaskets: One set(s) for each access door.
 3. Fan Belts: One set(s) for each air-handling unit fan if applicable.
- G. Section includes insulated, double-wall-casing, indoor, semi-custom air-handling units that are factory assembled using multiple section components.
 1. Refer to equipment schedule and air-handling unit schematic for unit components.

PART 2 PRODUCTS

2.01 GENERAL

- A. Provide factory fabricated indoor installed air handling units with capacity and accessories as indicated on the schedule. Units to have overall dimensions as indicated and fit into the space available with adequate clearance for service. Units to come completely assembled. Where shipping constraints prohibit shipment of fully assembled unit, disassemble units in factory into sections no smaller than necessary. Protect disassembled sections with weathertight shrinkwrap. Furnish units with sufficient gasket and bolts for reassembly in the field by the contractor. Electrical components and assemblies to comply with NEMA standards.
- B. Unit internal insulation must have a flame spread rating not over 25 and smoke developed rating no higher than 50 complying with NFPA 90A, standard for the installation of Air Conditioning and Ventilation Systems. Units to comply with NFPA 70, National Electrical code, as applicable for installation and electrical connection of ancillary electrical components of air handling units.

2.02 INDOOR, SEMI-CUSTOM AIR HANDLING UNIT MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Carrier Corporation; a unit of United Technologies Corp.
 2. Trane.
 3. YORK; a Johnson Controls company.
 4. Daikin Applied
 5. Ventrol
 6. Aeon
- B. Unit Casings:
1. Casing Air Pressure Performance Requirements:
 - a. Able to withstand up to 8 in-wc positive or negative static pressure.
 - b. Not to exceed 0.0042 inches per inch deflection at 1.5 times design static pressure up to a maximum of plus 8 in-wc in positive pressure section and minus 8 in-wc in negative pressure sections.
- C. Frame: Modular and providing overall structural integrity without reliance on casing panels for structural support.
- D. Base Rail:
1. Material: Galvanized steel.
 2. Height: 6 inches (150 mm) .
- E. Casing Joints: Hermetically sealed at each corner and around entire perimeter.
1. Casing Leakage: Seal joints and provide airtight access doors so that air leakage does not exceed one percent of design flow at the specified casing pressure.
- F. Outside Casing Wall:
1. Material: Galvanized steel, Minimum 16 gauge ((1.3 mm) (2.0 mm)) thick.
 2. Factory Finish: Provide manufacturer's standard finish.
- G. Inside Casing Wall:
1. Material: Galvanized steel, solid, minimum 18 gauge (1.3 mm) thick.
 - a. Provide panels with perforated liner in the fan section and other sections as shown on the drawings. Interior liner will be perforated galvanized. Minimum perforated panel thermal resistance will be R13 hr-ft²- deg F/BTU.
- H. Floor Plate:
1. Material: Galvanized steel, treadplate, maximum 18 gauge (1.3 mm (1.6 mm) (3.5 mm) thick. Construct with sufficient strength to support expected people and equipment loads associated with maintenance activities. The floor shall be of sufficient strength to support at 300 lb load during maintenance activities and shall deflect no more than 0.0042 inch per inch of panel span.
- I. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- J. Casing Insulation:
1. Materials: Glass-fiber blanket or board insulation, Type I or Type II ASTM C 1071
 2. Casing Panel R-Value: Minimum R-13.
 3. Insulation Thickness: 2 inches (50 mm).
 4. Thermal Break: Provide continuity of insulation with no through-casing metal in casing walls, floors, or roofs of air-handling unit.
- K. Panels, Doors, and Windows:
1. Panels:
 - a. Fabrication: Formed and reinforced, double-wall and insulated panels of same materials and thicknesses as casing.
 - b. Fasteners: Two or more camlock type for panel lift-out operation. Arrangement shall allow panels to be opened against airflow
 - c. Gasket: Neoprene, applied around entire perimeters of panel frames.

- d. Size: Large enough to allow unobstructed access for inspection and maintenance of air-handling unit's internal components. Minimum 18 inches (450 mm) wide by full height of unit casing up to a maximum height of (1500 mm) 72 inches (1800 mm).
- 2. Doors:
 - a. Fabrication: Formed and reinforced, double-wall and insulated panels of same materials and thicknesses as casing.
 - b. Hinges: A minimum of two ball-bearing hinges or stainless-steel piano hinge and two wedge-lever latches, operable from inside and outside. Arrange doors to be opened against airflow. Provide safety latch retainers on doors so that doors do not open uncontrollably.
 - c. Gasket: Neoprene, applied around entire perimeters of panel frames.
 - d. Size: Large enough to allow for unobstructed access for inspection and maintenance of air-handling unit's internal components. Minimum 18 inches (450 mm) wide by full height of unit casing up to a maximum height of (1500 mm) 72 inches (1800 mm).
- 3. Windows:
 - a. Construction: Fabricate windows in access panels and doors of double-glazed, safety glass with an airspace between panes and sealed with interior and exterior rubber seals.
 - b. Size: Minimum 6 inches (150 mm), square.
- 4. Locations and Applications:
 - a. Fan Section: Doors, with windows.
 - b. Coil Section: Doors
 - c. Access Section: Doors.
 - d. Access Sections Immediately Upstream and Downstream of Coil Sections: Doors.
 - e. Damper Section: Doors.
 - f. Filter Section: Doors large enough to allow periodic removal and installation of side access filters. For front or back access filter housings, provide access sections immediately upstream or downstream of filter sections with doors large enough to allow filter installation and removal.
 - g. Mixing Section: Doors, with windows.
- 5. Service Lights: LED vaporproof luminaire with individual switched junction box located outside, adjacent to each access door and panel. Manufacturer to provide all internal wiring, switches, conduit, etc. to a single electrical junction box per unit for 120V connection in the field.
 - a. Locations: Each section accessed with door or panel.
- 6. Convenience Outlets: One 20-A duplex GFCI receptacle per location with junction box located on outside casing wall.
 - a. Locations: Each section accessed with a door or panel.
- L. Condensate Drain Pans:
 - 1. Construction:
 - a. Double-wall, stainless-steel sheet with space between walls filled with foam insulation and moisture-tight seal.
 - 2. Drain Connection:
 - a. Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.
 - b. Minimum Connection Size: (DN 25) NPS 2 (DN 50)
 - 3. Slope: Minimum 0.125-in./ft (10-mm/mm) slope, to comply with ASHRAE 62.1, in at least two planes to collect condensate from cooling coils and to direct water toward drain connection.
 - 4. Length: Extend drain pan downstream from leaving face for minimum distance equal to one-half the height of the coil section served, however not less than 18 inches.
 - 5. Width: Entire width of water producing device.

6. Depth: A minimum of 2 inches (50 mm) deep.
7. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.

2.03 FAN, DRIVE, AND MOTOR SECTION

- A. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.
 1. Shafts: With field-adjustable alignment.
 - a. Turned, ground, and polished hot-rolled steel with keyway. Ship with a protective coating of lubricating oil.
 - b. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
- B. Centrifugal Fan Housings: Formed- and reinforced-steel panels to form curved scroll housings with shaped cutoff and spun-metal inlet bell.
 1. Bracing: Steel angle or channel supports for mounting and supporting fan scroll, wheel, motor, and accessories.
 2. Horizontal-Flanged, Split Housing: Bolted construction.
 3. Housing for Supply Fan: Attach housing to fan-section casing with metal-edged flexible duct connector.
 4. Flexible Connector: Factory fabricated with a fabric strip (89 mm) 5-3/4 inches (146 mm) wide attached to two strips of 2-3/4 inches (70 mm) wide, 0.028-inch- (0.7-mm-) thick, galvanized-steel sheet.
 - a. Flexible Connector Fabric: Glass fabric, double coated with neoprene. Fabrics, coatings, and adhesives shall comply with UL 181 UL 181, Class 1.
 - 1) Fabric Minimum Weight: 26 oz./sq. yd. (880 g/sq. m).
 - 2) Fabric Minimum Tensile Strength: 480 lbf/inch (84 N/mm) in the warp and 360 lbf/inch (63 N/mm) in the filling.
 - 3) Fabric Minimum Service Temperature Range: Minus 40 to plus 200 deg F (Minus 40 to plus 93 deg C).
- C. Plenum Fan Housings: Steel frame and panel; fabricated without fan scroll and volute housing. Provide inlet screens for Type SWSI fans.
- D. Plenum Fan Arrays: Contained as defined in AHRI 430 (I-P) . Steel or aluminum frame with inlet cone and structural framing around each fan built into an array of multiple fans. Provide motor operated or backdraft, dampers at each fan to prevent short circuiting of flow if one fan is not operating.
- E. Backward-Inclined, Centrifugal Fan Wheels: Construction with curved inlet flange, backplate, backward-inclined blades welded or riveted to flange and backplate; steel hub riveted to backplate and fastened to shaft with setscrews.
- F. Forward-Curved, Centrifugal Fan Wheels: Inlet flange, backplate, and shallow blades with inlet and tip curved forward in direction of airflow and mechanically fastened to flange and backplate; steel hub swaged to backplate and fastened to shaft with setscrews.
- G. Airfoil, Centrifugal Fan Wheels: Smooth-curved inlet flange, backplate, and hollow die-formed airfoil-shaped blades continuously welded at tip flange and backplate; steel hub riveted to backplate and fastened to shaft with setscrews.
- H. Fan Shaft Bearings:
 1. Pre-lubricated and Sealed, Ball Bearings: Self-aligning, pillow-block type with an L-50 rated life of 200,000 hours according to ABMA 9.
 2. Grease-Lubricated, Tapered-Roller Bearings: Self-aligning, pillow-block type with double-locking collars and two-piece, cast-iron housing with grease lines extended to outside unit and an L-50 rated life of 200,000 hours according to ABMA 11.

3. Grease-Lubricated Bearings: Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing and an L-50 rated life of 200,000
- I. Belt Drives: Factory mounted, with adjustable alignment and belt tensioning, and with 1.5 service factor based on fan motor.
 1. Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
 2. Motor Pulleys: Adjustable pitch for use with 5-hp motors and smaller; fixed pitch for use with motors larger than 5 hp. Select pulley size so pitch adjustment is at the middle of adjustment range at fan design conditions.
 3. Belts: Oil resistant, non-sparking, and non-static; in matched sets for multiple-belt drives.
 4. Belt Guards: Comply with requirements specified by OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards"; 0.146 inch- (2.7 mm-) thick, 3/4-inch (20-mm) diamond-mesh wire screen, welded to steel angle frame; prime coated.
- J. Discharge Dampers: Heavy-duty steel assembly with channel frame and sealed ball bearings, and opposed blades constructed of two plates formed around and welded to shaft, with blades linked out of airstream to single control lever.
- K. Internal Vibration Isolation: Fans shall be factory mounted with manufacturer's standard vibration isolation mounting devices having a minimum static deflection of 1 inch (25 mm).
- L. Motor: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 1. Enclosure Type: Totally enclosed, fan cooled.
 2. NEMA Premium Efficient motors as defined in NEMA MG 1.
 3. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 4. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
 5. Mount unit-mounted disconnect switches on exterior of unit.
- M. Variable-Frequency Motor Controller: Serving each fan individually in fan array unless noted otherwise per contract drawings.
 1. VFD shall comply with division 26, section 26 29 23.

2.04 COIL SECTION

- A. General Requirements for Coil Section:
 1. Comply with AHRI 410 (SI/I-P).
 2. Fabricate coil section to allow removal and replacement of coil for maintenance and to allow in-place access for service and maintenance of coil(s).
 3. Coils shall not act as structural component of unit.
- B. Casing: Provide access to both sides of coils. Enclose coils with headers and return bends exposed outside casing. Slide coils into casing through removable end panel with blank off sheets and sealing collars at connection penetrations.
- C. The coil section shall be provided complete with coil and coil holding frame. The coils shall be installed such that headers and return bends are enclosed by unit casings.
- D. Drain Pans: 24 inch downstream of coil and down spouts for cooling coil banks more than one coil high. if two or more cooling coils are stacked in the unit, an intermediate drain pan shall be installed between each coil and be of the same materials as the primary drain pan Like the primary drain pan, the intermediate drain pan shall be designed being of sufficient size to collect all condensate produced from the coil and sloped to promote positive drainage to eliminate stagnant water conditions. The intermediate pan shall begin at the leading face of the water-producing device and be of sufficient length extending downstream to prevent condensate from passing through the air stream of the lower coil. intermediate drain pan shall

include downspouts to direct condensate to the primary drain pan. The outlet shall be located at the lowest point of the pan and shall be sufficient diameter to preclude drain pan overflow under any normally expected operating condition.

- E. Coil with inspection: The coils section shall include an inspection section complete with a double-wall, removable door downstream of the coil for inspection, cleaning, and maintenance. Interior and exterior door panels shall be of the same construction as the interior and exterior wall panels, respectively. All doors shall be provided with a thermal break construction of door panel and door frame.
 - 1. Casing penetrations supplied for hydronic drain and vents. Piping connector shall provide extended piping.
 - 2. No casing penetrations supplied for hydronic drain and vent. If required, piping contractor will need to drill drain and vent penetrations using factory located features provided in coil panel.
- F. Water Coils: The coils shall have aluminum fins and seamless copper tubes. Copper fins may be applied to coils with 5/8-inch tubes. Fins shall have collars drawn, belled, and firmly bonded to tubes by mechanical expansion of the tubes. The coil casing may be galvanized or stainless steel.
 - 1. The coils shall be proof-tested to 300 psig and leak-tested under water to 200 psig
 - 2. CI connections are constructed of steel pipe with male connections. Type P or TT coil connections do not extend out of unit casing. All other water coil types have connections that extend out beyond unit casing.
 - 3. Tubes are 5/8" OD 0.02" thick copper.
- G. Refrigerant Cooling Coils: The coils shall have aluminum fins and seamless copper tubes. The fins shall have collars drawn, belled, and firmly bonded to tubes by mechanical expansion of the tubes. Suction and liquid line connections shall extend to the unit exterior. The coil casing may be galvanized or stainless steel.
 - 1. The coils shall be proof-tested to 715 psig and leak-tested to 300 psig air pressure under water. After testing, the inside of the coils shall be dried, all connections shall be sealed, and the coil shall be shipped with a charge of dry air.
 - 2. Suction headers and liquid connections shall be constructed of copper tubing with connections entering unit casings to permit sweat connections to refrigerant line. The coils shall have equalizing vertical distributors sized according to the capacities of the coils.
 - 3. Tubes are 1/2" OD 0.016" thick copper.
 - 4. R454B Leak Detection Sensor: A factory installed A2L class gas sensor designed for R454B refrigerant detection will be installed in the DX coil sections with R54B refrigerant. It utilizes thermal conductivity technology for quick and accurate leak detection and features automated self-calibration, self-diagnostics, immunity to poisoning and a 15 years life. The sensor comes set with a 15% LFL alarm threshold with $\pm 2.5\%$ accuracy at 68°F and $\pm 5\%$ accuracy across the rest of the operating range of 40°F to 175°F. Coil connections shall be stubbed into the tunnel adjacent to the coil section. Piping will not be extended outside of the unit. Piping contractor shall provide extending piping.
- H. Air Coils
 - 1. Certify capacities, pressure drops, and selection procedures in accordance with AHRI 410.

2.05 AIR FILTRATION SECTION

- A. Particulate air filtration is specified in Section 23 41 00 "Particulate Air Filtration."
- B. High-efficiency particulate air (HEPA) filtration is specified in Section 23 41 33 "High-Efficiency Particulate Air Filtration."
- C. Front- Access Filter Mounting Frames:
 - 1. Particulate Air Filter Frames: Galvanized-steel framing members with access for filter servicing, cut to size and pre-punched for assembly into modules. Vertically support filters

- to prevent deflection of horizontal members without interfering with either filter installation or operation.
- a. Prefilters: Incorporate a separate 2-inch- (50-mm-) thick track with spring clips, with same access as primary filter.
 - b. Sealing: Full periphery foam gaskets.
2. HEPA Filter Frames: Aluminum framing members, cut to size and pre-punched for assembly into modules. Vertically support filters to prevent deflection of horizontal members without interfering with either filter installation operation. Bolted filter-sealing mechanism shall mount and continuously seal each individual filter.
 - a. Prefilters: Incorporate a separate 2-inch- (50-mm-) thick track with spring clips with same access as primary filter.
 - b. Sealing: Gasketed, hand-crank locking mechanism to provide positive-sealing for each filter to ensure seal between filter elements to prevent bypass of unfiltered air.
- D. Side-Access Filter Mounting Frames:
1. Particulate Air Filter Frames: Match inner casing and outer casing material, and insulation thickness. Galvanized steel track.
 - a. Prefilters: Incorporate an integral 2-inch- (50-mm-) thick track with same access as primary filter.
 - b. Sealing: Incorporate positive-sealing device to ensure seal between gasketed material on channels to seal top and bottom of filter cartridge frames to prevent bypass of unfiltered air.
 2. HEPA Filter Frames:
 - a. Frames: Match inner casing and outer casing material, and insulation thickness. Aluminum track.
 - b. Prefilters: Incorporate an integral 2-inch- (50-mm-) thick track,
 - c. Sealing: Incorporate positive-sealing clamping device on each filter between gasket seal on all sides of filter cartridge frames to prevent bypass of unfiltered air.

2.06 DAMPERS

- A. General Requirements for Dampers: Leakage rate, according to AMCA 500 AMCA 500, "Laboratory Methods for Testing Dampers for Rating," 4 cfm/sq. ft. (20 L/s per sq. m) at 1-inch wg (250 Pa) and 8 cfm/sq. ft. (40 L/s per sq. m) at 4-inch wg (1.0 MPa).
- B. Damper Operators: Comply with requirements in Section 230900 "Control Dampers."
- C. Face-and-Bypass Dampers: Opposed-blade, galvanized-steel dampers with steel operating rods rotating in sintered bronze or nylon bearings mounted in a single galvanized-steel frame and with operating rods connected with a common linkage. Provide blade gaskets and edge seals, and mechanically fasten blades to operating rod.
- D. Outdoor- and Return-Air Dampers: Low-leakage, double-skin, airfoil-blade, galvanized-steel dampers with compressible jamb seals and extruded-vinyl blade edge seals in opposed-blade arrangement with steel operating rods rotating in stainless-steel sleeve bearings mounted in a single galvanized-steel frame, and with operating rods connected with a common linkage. Leakage rate shall not exceed 4 cfm/sq. ft. (20 L/s per sq. m) at 1-inch wg (250 Pa) and 8 cfm/sq. ft. (40 L/s per sq. m) at 4-inch wg (1.0 MPa).
- E. Mixing Section: Multiple-blade, air-mixer assembly located immediately downstream of mixing section.
- F. Combination Filter and Mixing Section:
 1. Cabinet support members shall hold 2-inch- (50-mm-) thick, pleated, flat, permanent or throwaway filters.
 2. Multiple-blade, air-mixer assembly shall mix air to prevent stratification, located immediately downstream of mixing box.

2.07 SOUND ATTENUATORS

- A. General Requirements:
 - 1. Factory fabricated.
 - 2. Fire Performance Characteristics: Adhesives, sealants, packing materials, and accessory materials with flame-spread index not exceeding 25 and smoke-developed index not exceeding 50, ASTM E84.
 - 3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with ASHRAE 62.1.
- B. Shape: Rectangular, straight.
- C. Rectangular Silencer Outer Casing: Galvanized steel.
- D. Round Silencer Outer Casing: Galvanized steel.
- E. Inner Casing and Baffles: Galvanized steel.
- F. Principal Sound-Absorbing Mechanism:
 - 1. Controlled impedance membranes and broadly tuned resonators without absorptive media.
 - 2. Dissipative type with fill material.
 - a. Fill Material: Inert and vermin-proof fibrous material, packed under not less than 5 percent compression.
 - b. Erosion Barrier: Polymer bag enclosing fill, and heat sealed before assembly.
 - 3. Lining: None.
 - 4. Fabricate silencers to form rigid units that will not pulsate, vibrate, rattle, or otherwise react to system pressure variations. Do not use mechanical fasteners for unit assemblies.
 - 5. Flange connections.
 - 6. Suspended Units: Factory-installed suspension hooks or lugs attached to frame in quantities and spaced to prevent deflection or distortion.
 - 7. Reinforcement: Cross or trapeze angles for rigid suspension.
 - 8. Joints: Lock formed and sealed, continuously welded or flanged.

2.08 AIR-TO-AIR ENERGY RECOVERY

- A. Heat Wheels:
 - 1. Casing:
 - a. Galvanized steel, stainless steel, or aluminum with manufacturer's standard finish.
 - b. Integral purge section limiting carryover of exhaust air to between 0.05 percent at 1.6-inch wg and 0.20 percent at 4-inch wg (0.5 percent at 400-Pa and 0.20 percent at 1000-Pa) differential pressure.
 - c. Casing seals on periphery of rotor, on duct divider, and on purge section.
 - d. Support rotor on grease-lubricated ball bearings with extended grease fittings. Mount horizontal wheels on tapered roller bearing.
 - 2. Rotor: Aluminum or polymer segmented wheel, strengthened with radial spokes, with nontoxic, noncorrosive, silica-gel desiccant coating.
 - 3. Drive: Fractional horsepower motor and gear reducer, with speed changed by variable-frequency controller. Permanently lubricated wheel bearings with an L-10.
 - 4. "Controls:
 - a. Starting relay, factory mounted and wired, and manual motor starter for field wiring.
 - b. Variable-frequency controller, factory mounted and wired, with exhaust- and outdoor-air sensors, automatic changeover thermostat and set-point adjuster, to vary rotor speed and maintain air differential temperature above set point. Provide maximum rotor speed when exhaust-air temperature is less than outdoor-air temperature.
 - c. Pilot-Light Indicator: Display rotor rotation and speed.
 - d. Speed Settings: Adjustable settings for maximum and minimum rotor speed limits.

2.09 MATERIALS

- A. Steel:
 - 1. ASTM A 36/A 36M for carbon structural steel.
 - 2. ASTM A 568/A 568M for steel sheet.
- B. Stainless Steel:
 - 1. Manufacturer's standard grade for casing.
 - 2. Manufacturer's standard type, ASTM A240/A240M ASTM A 240/A 240M for bare steel exposed to airstream or moisture.
- C. Galvanized Steel: ASTM A653/A653M ASTM A 653/A 653M.
- D. Aluminum: ASTM B209/B209M.

2.10 SOURCE QUALITY CONTROL

- A. AHRI 430 (I-P) Certification: Air-handling units and their components shall be factory tested according to AHRI 430 (I-P) AHRI 430 and shall be listed and labeled by AHRI.
- B. AHRI 1060 (I-P) Certification: Air-handling units that include air-to-air energy recovery devices shall be factory tested according to AHRI 1060 (I-P) and shall be listed and labeled by AHRI.
- C. AMCA 301 or AHRI 260 (I-P): Air-handling unit fan sound ratings shall comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data," or AHRI 260 (I-P), "Sound Rating of Ducted Air Moving and Conditioning Equipment."
- D. Fan Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Test fans according to AMCA 300 AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Fans shall bear AMCA-certified sound ratings seal.
- E. Fan Performance Rating: Factory test fan performance for airflow, pressure, power, air density, rotation speed, and efficiency. Rate performance according to AMCA 210 , "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating."
- F. Water Coils: Factory tested to 300 psig (2070 kPa) according to AHRI 410 (SI/I-P) and ASHRAE 33.
- G. Steam Coils: Factory tested to 300 and 200 psig (2070 and 1380 kPa) underwater according to AHRI 410 (SI/I-P) and ASHRAE 33.
- H. Refrigerant Coils: Factory tested to minimum 450-psig (3105-kPa) internal pressure and to minimum 300-psig (2070-kPa) internal pressure while underwater, according to AHRI 410 (SI/I-P) and ASHRAE 33.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine casing insulation materials and filter media before air-handling unit installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.
- C. Examine roughing-in for steam, hydronic, and condensate drainage piping systems and electrical services to verify actual locations of connections before installation.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Equipment Mounting:
 - 1. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."
- B. Arrange installation of units to provide access space around air-handling units for service and maintenance.

- C. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with new, clean filters.
- D. Install filter-gauge, static-pressure taps upstream and downstream of filters. Mount filter gauges on outside of filter housing or filter plenum in accessible position. Provide filter gauges on filter banks, installed with separate static-pressure taps upstream and downstream of filters.
- E. Connect duct to air-handling units with flexible connections. Comply with requirements in Section 23 33 00 "Air Duct Accessories."

3.03 CONNECTIONS

- A. Piping Connections
 - 1. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
 - 2. Where installing piping adjacent to air-handling unit, allow for service and maintenance.
 - 3. Connect piping to air-handling units mounted on vibration isolators with flexible connectors.
 - 4. Connect condensate drain pans using NPS 1-1/4 (DN 32) ASTM B88, Type M (ASTM B 88M, Type C) copper tubing. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.
 - 5. Hot- and Chilled-Water Piping: Comply with applicable requirements in Section 23 21 13 "Hydronic Piping" and Section 23 21 16 "Hydronic Piping Specialties." Install shutoff valve and union or flange at each coil supply connection. Install balancing valve and union or flange at each coil return connection.
 - 6. Steam and Condensate Piping: Comply with applicable requirements in Section 23 22 13 "Steam and Condensate Heating Piping" and Section 23 22 16 "Steam and Condensate Heating Piping Specialties." Install shutoff valve at steam supply connections, float and thermostatic trap, and union or flange at each coil return connection. Install gate valve and inlet strainer at supply connection of dry steam humidifiers, and inverted bucket steam trap to condensate return connection.
 - 7. Refrigerant Piping: Comply with applicable requirements in Section 23 23 00 "Refrigerant Piping." Install shutoff valve and union or flange at each supply and return connection.
- B. Duct Connections
- C. Electrical Connections
 - 1. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
 - 2. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."
 - 3. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.
 - 4. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
 - a. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 26 05 53 "Identification for Electrical Systems."
- D. Control Connections
 - 1. Install control and electrical power wiring to field-mounted control devices.
 - 2. Connect control wiring according to Section 26 05 23 "Control-Voltage Electrical Power Cables."

3.04 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Leak Test: After installation, fill water and steam coils with water, and test coils and connections for leaks.
 2. Charge refrigerant coils with refrigerant and test for leaks if applicable.
 3. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 4. HEPA Filters: Pressurize housing to a minimum of 3-inch wg (750 Pa) or to designed operating pressure, whichever is higher; test housing joints, door seals, and sealing edges of filter with soapy water to check for air leaks.
 5. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Air-handling unit or components will be considered defective if unit or components do not pass tests and inspections.
- C. Prepare test and inspection reports.

3.05 START UP SERVICE

- A. Perform startup service.
1. Complete installation and startup checks according to manufacturer's written instructions.
 2. Verify that shipping, blocking, and bracing are removed.
 3. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, controllers, and switches.
 4. Verify proper motor rotation direction, free fan wheel rotation, and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.
 5. Verify that bearings, pulleys, belts, and other moving parts are lubricated with factory-recommended lubricants.
 6. Verify that face-and-bypass dampers provide full face flow if applicable.
 7. Verify that outdoor- and return-air mixing dampers open and close, and maintain minimum outdoor-air setting.
 8. Comb coil fins for parallel orientation.
 9. Verify that proper thermal-overload protection is installed for electric coils.
 10. Install new, clean filters.
 11. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.
- B. Starting procedures for air-handling units include the following:
1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm. Replace fan and motor pulleys as required to achieve design conditions.
 2. Measure and record motor electrical values for voltage and amperage.
 3. Manually operate dampers from fully closed to fully open position and record fan performance.

3.06 FIELD TESTING

3.07 PAINTING

3.08 IDENTIFICATION

3.09 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Comply with requirements in Section 23 05 93 "Testing, Adjusting, and Balancing for HVAC" for air-handling system testing, adjusting, and balancing.

3.10 CLEANING

- A. After completing system installation and testing, adjusting, and balancing air-handling unit and air-distribution systems and after completing startup service, clean air-handling units internally

to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

3.11 DEMONSTRATION AND TRAINING

- A. Train Owner's maintenance personnel to adjust, operate, and maintain air-handling units.

END OF SECTION

SECTION 23 81 26.13
SMALL-CAPACITY SPLIT-SYSTEM AIR CONDITIONERS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Air-source heat pumps.
- B. Forced air furnaces.
- C. Air cooled condensing units.
- D. Indoor air handling (fan and coil) units for ducted systems.
- E. Indoor air handling (fan and coil) units for ductless systems.
- F. Controls.

1.02 RELATED REQUIREMENTS

- A. Section 23 09 13 - Instrumentation and Control Devices for HVAC: Thermostats, humidistats, time clocks.
- B. Section 23 31 00 - HVAC Ducts and Casings.
- C. Section 26 05 83 - Wiring Connections: Electrical characteristics and wiring connections and installation and wiring of thermostats and other controls components.

1.03 REFERENCE STANDARDS

- A. AHRI 210/240 - Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment; 2023.
- B. AHRI 520 - Performance Rating of Positive Displacement Condensing Units; 2004.
- C. ASHRAE Std 15 - Safety Standard for Refrigeration Systems; 2024, with Errata (2025).
- D. ASHRAE Std 23 - Methods for Performance Testing Positive Displacement Refrigerant Compressors and Compressor Units; 2022.
- E. ASHRAE Std 52.2 - Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size; 2025.
- F. ASHRAE Std 90.1 I-P - Energy Standard for Buildings Except Low-Rise Residential Buildings; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- G. NEMA MG 00001 - Motors and Generators; 2024.
- H. NFPA 31 - Standard for the Installation of Oil-Burning Equipment; 2024.
- I. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2024.
- J. {RSTEMP#1880}NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems; National Fire Protection Association{CH#132213}.
- K. NFPA 211 - Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances; 2024.
- L. UL 207 - Standard for Refrigerant-Containing Components and Accessories, Nonelectrical; Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide rated capacities, weights, accessories, electrical nameplate data, and wiring diagrams.
- C. Shop Drawings: Indicate assembly, required clearances, and location and size of field connections.

- D. Design Data: Indicate refrigerant pipe sizing.
- E. Manufacturer's Instructions: Indicate rigging, assembly, and installation instructions.
- F. Sustainable Design Documentation: Submit manufacturer's product data on refrigerant used, showing compliance with specified requirements.
- G. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listing.
- H. Warranty: Submit manufacturers warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.
- I. Project Record Documents: Record actual locations of components and connections.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
- B. Installer Qualifications: Company specializing in performing the work of this section with minimum ____ years of experience and approved by manufacturer.

1.06 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. Provide three year manufacturers warranty for solid state ignition modules.
- C. Provide five year manufacturers warranty for compressor heat exchangers.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Carrier Corporation; ____: www.carrier.com/#sle.
- B. Trane Technologies, PLC; ____: www.trane.com/#sle.

2.02 SYSTEM DESIGN

- A. Split-System Heating and Cooling Units: Self-contained, packaged, matched factory-engineered and assembled, pre-wired indoor and outdoor units; UL listed.
 - 1. Heating and Cooling: Air-source electric heat pump located in outdoor unit with evaporator; auxiliary electric heat.
 - 2. Provide refrigerant lines internal to units and between indoor and outdoor units, factory cleaned, dried, pressurized and sealed, with insulated suction line.
- B. Performance Requirements: See Drawings for additional requirements.
 - 1. Efficiency:
 - a. Seasonal Energy Efficiency Ratio: 10.0, minimum.
 - b. Energy Efficiency Ratio: 12.
 - c. Heating Seasonal Performance Factor: 6.8, minimum.
- C. Electrical Characteristics:
 - 1. ____ kW.
 - 2. ____ volts, single phase, 60 Hz.
 - 3. ____ amperes maximum fuse size.
 - 4. Disconnect Switch: Factory mount disconnect switch on equipment under provisions of Section 26 05 83.

2.03 INDOOR AIR HANDLING UNITS FOR DUCTED SYSTEMS

- A. Indoor Units: Self-contained, packaged, factory assembled, pre-wired unit consisting of cabinet, supply fan, heating and cooling element(s), controls, and accessories; wired for single power connection with control transformer.
 - 1. Air Flow Configuration: Upflow.

2. Cabinet: Steel with baked enamel finish, easily removed and secured access doors with safety interlock switches, glass fiber insulation with reflective liner.
- B. Supply Fan: Centrifugal type rubber mounted with direct or belt drive with adjustable variable pitch motor pulley.
 1. Motor: NEMA MG 1; 1750 rpm single speed, permanently lubricated, hinge mounted.
 2. Motor Electrical Characteristics:
- C. Air Filters: 1 inch (25 mm) thick urethane, washable type arranged for easy replacement.
- D. Evaporator Coils: Copper tube aluminum fin assembly, galvanized or polymer drain pan sloped in all directions to drain, drain connection, refrigerant piping connections, restricted distributor or thermostatic expansion valve.
 1. Construction and Ratings: In accordance with AHRI 210/240 and UL 207.
 2. Manufacturers: System manufacturer.

2.04 INDOOR AIR HANDLING UNITS FOR DUCTLESS SYSTEMS

- A. Indoor Units: Self-contained, packaged, factory assembled, pre-wired unit consisting of cabinet, supply fan, evaporator coil, and controls; wired for single power connection with control transformer.
 1. Location: Ceiling.
 2. Sound Rating:
 3. Cabinet: Galvanized steel.
 4. Fan: Line-flow fan direct driven by a single motor.
 5. Filter return air with washable, antioxidant pre-filter and a pleated anti-allergy enzyme filter.
 6. Wall-Mounted Units:
- B. Evaporator Coils: Copper tube aluminum fin assembly, galvanized or polymer drain pan sloped in all directions to drain, drain connection, refrigerant piping connections, restricted distributor or thermostatic expansion valve.
 1. Construction and Ratings: In accordance with AHRI 210/240 and UL 207.
 2. Manufacturer: System manufacturer.

2.05 OUTDOOR UNITS

- A. Outdoor Units: Self-contained, packaged, pre-wired unit consisting of cabinet, with compressor and condenser.
 1. Refrigerant: Use only refrigerants that have ozone depletion potential (ODP) of zero and global warming potential (GWP) no greater than that allowed by federal code.
 2. Refrigerant: R-454B.
 3. Construction and Ratings: In accordance with AHRI 210/240 with testing in accordance with ASHRAE Std 23 and UL 207.
- B. Compressor: Hermetic, two speed 1800 and 3600 rpm, AHRI 520 resiliently mounted integral with condenser, with positive lubrication, crankcase heater, high-pressure control, motor overload protection, service valves and drier. Provide time delay control to prevent short cycling and rapid speed changes.
- C. Air Cooled Condenser: Aluminum fin and copper tube coil, AHRI 520 with direct drive axial propeller fan resiliently mounted, galvanized fan guard.
 1. Condenser Fans: Direct-drive propeller type.
 2. Condenser Fan Motor: Enclosed, 1-phase type, permanently lubricated.
- D. Coil: Air-cooled, aluminum fins bonded to copper tubes.
- E. Accessories: Filter drier, high-pressure switch (manual reset), low pressure switch (automatic reset), service valves and gauge ports, thermometer well (in liquid line).
 1. Provide thermostatic expansion valves.
 2. Provide heat pump reversing valves.

- F. Operating Controls:
 - 1. Control by room thermostat to maintain room temperature setting.
 - 2. Low Ambient Kit: Provide refrigerant pressure switch to cycle condenser fan on when condenser refrigerant pressure is above 285 psig (1965 kPa) and off when pressure drops below 140 psig (965 kPa) for operation to 0 degrees F (-18 degrees C).
- G. Mounting Pad: Precast concrete parking bumpers, minimum 4 inches (100 mm) square; minimum of two located under cabinet feet.

2.06 OIL FURNACE COMPONENTS

- A. Combustion Chamber: Welded stainless steel with precast refractory, UL listed.
- B. Burner: High-pressure atomizing type, rubber mounted, adjustable combustion air blower, integrated fuel pump, hinged flame inspection port, cadmium sulphide flame sensor, electrodes, ignition transformer, oil nozzle.
 - 1. Barometric draft regulator in flue.
 - 2. Non-corrosive combustion air blower with permanently lubricated motor.
- C. Burner Safety Controls:
 - 1. Time delay relay limits time for establishment of main flame.
 - 2. Flame sensor monitors flame continuously during burner operation and stops burner on flame failure with manual reset.
- D. Operating Controls:
 - 1. Burner controlled by room thermostat to maintain room temperature setting.
 - 2. Supply fan energized from bonnet temperature independent of burner controls, with fixed timed on delay, with manual switch for continuous fan operation.

2.07 ELECTRIC FURNACE COMPONENTS

- A. Electric Heater: Helix wound bare nichrome wire heating elements arranged in incremental stages of 5 kW each, with porcelain insulators.
- B. Operating Controls:
 - 1. Heater stages energized in sequence with pre-determined delay between heating stages.
 - 2. High limit temperature control to de-energize heating elements, with automatic reset.

2.08 ACCESSORY EQUIPMENT

- A. Room Thermostat: Wall-mounted, electric solid state microcomputer based room thermostat with remote sensor to maintain temperature setting; low-voltage; with following features:
 - 1. System selector switch (heat-off-cool) and fan control switch (auto-on).
 - 2. Automatic switching from heating to cooling.
 - 3. Preferential rate control to minimize overshoot and deviation from setpoint.
 - 4. Set-up for four separate temperatures per day.
 - 5. Instant override of setpoint for continuous or timed period from one hour to 31 days.
 - 6. Short cycle protection.
 - 7. Programming based on weekdays, Saturday and Sunday.
 - 8. Selection features including degree F or degree C display, 12 or 24 hour clock, keyboard disable, remote sensor, fan on-auto.
 - 9. Battery replacement without program loss.
 - 10. Thermostat Display:
 - a. Time of day.
 - b. Actual room temperature.
 - c. Programmed temperature.
 - d. Programmed time.
 - e. Duration of timed override.
 - f. Day of week.
 - g. System Mode Indication: Heating, Cooling, Fan Auto, Off, and On, Auto or On, Off.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that substrates are ready for installation of units and openings are as indicated on shop drawings.
- B. Verify that proper power supply is available and in correct location.
- C. Verify that proper fuel supply is available for connection.
- D. Verify that water supply is available for humidifier.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions and requirements of local authorities having jurisdiction.
- B. Install in accordance with NFPA 90A and NFPA 90B.
- C. Install oil fired furnaces in accordance with NFPA 31.
- D. Provide vent connections in accordance with NFPA 211.
- E. Install refrigeration systems in accordance with ASHRAE Std 15.

END OF SECTION

SECTION 26 05 19
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Single conductor building wire.
- B. Manufactured wiring systems.
- C. Wiring connectors.
- D. Electrical tape.
- E. Wire pulling lubricant.
- F. Cable ties.

1.02 RELATED REQUIREMENTS

- A. Section 07 84 00 - Firestopping.
- B. Section 26 05 26 - Grounding and Bonding for Electrical Systems: Additional requirements for grounding conductors and grounding connectors.
- C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- D. Section 28 46 00 - Fire Detection and Alarm: Fire alarm system conductors and cables.

1.03 REFERENCE STANDARDS

- A. ASTM B3 - Standard Specification for Soft or Annealed Copper Wire; 2013 (Reapproved 2024).
- B. ASTM B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft; 2023.
- C. ASTM B33 - Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes; 2010, with Editorial Revision (2020).
- D. ASTM B787/B787M - Standard Specification for 19 Wire Combination Unilay-Stranded Copper Conductors for Subsequent Insulation; 2004 (Reapproved 2020).
- E. ASTM D3005 - Standard Specification for Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape; 2024.
- F. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.
- G. NEMA WC 70 - Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy; 2021.
- H. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- I. UL 44 - Thermoset-Insulated Wires and Cables; Current Edition, Including All Revisions.
- J. UL 83 - Thermoplastic-Insulated Wires and Cables; Current Edition, Including All Revisions.
- K. UL 183 - Manufactured Wiring Systems; Current Edition, Including All Revisions.
- L. UL 267 - Outline of Investigation for Wire-Pulling Compounds; Current Edition, Including All Revisions.
- M. UL 486A-486B - Wire Connectors; Current Edition, Including All Revisions.
- N. UL 486C - Splicing Wire Connectors; Current Edition, Including All Revisions.
- O. UL 510 - Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate sizes of raceways, boxes, and equipment enclosures installed under other sections with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
 - 2. Coordinate with electrical equipment installed under other sections to provide terminations suitable for use with the conductors to be installed.
 - 3. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conductors and cables, including detailed information on materials, construction, ratings, listings, and available sizes, configurations, and stranding.
- C. Manufactured Wiring System Shop Drawings: Provide plan views indicating proposed system layout with components identified; indicate branch circuit connections.

1.06 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store conductors and cables in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 CONDUCTOR AND CABLE APPLICATIONS

- A. Do not use conductors and cables for applications other than as permitted by NFPA 70 and product listing.
- B. Provide single conductor building wire installed in suitable raceway unless otherwise indicated, permitted, or required.
- C. Nonmetallic-sheathed cable is not permitted.
- D. Manufactured wiring systems are permitted only as follows:

2.02 CONDUCTOR AND CABLE GENERAL REQUIREMENTS

- A. Provide products that comply with requirements of NFPA 70.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, etc. as required for a complete operating system.
- D. Comply with NEMA WC 70.
- E. Thermoplastic-Insulated Conductors and Cables: Listed and labeled as complying with UL 83.
- F. Thermoset-Insulated Conductors and Cables: Listed and labeled as complying with UL 44.
- G. Conductor Material:
 - 1. Provide copper conductors only. Aluminum conductors are not acceptable for this project. Conductor sizes indicated are based on copper.
 - 2. Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B3, ASTM B8, or ASTM B787/B787M unless otherwise indicated.
 - 3. Tinned Copper Conductors: Comply with ASTM B33.

- H. Conductor Color Coding:
1. Color code conductors as indicated unless otherwise required by the authority having jurisdiction. Maintain consistent color coding throughout project.
 2. Color Coding Method: Integrally colored insulation.
 3. Color Code:
 - a. 208Y/120 V, 3 Phase, 4 Wire System:
 - 1) Phase A: Black.
 - 2) Phase B: Red.
 - 3) Phase C: Blue.
 - 4) Neutral/Grounded: White.
 - b. Equipment Ground, All Systems: Green.
 - c. For modifications or additions to existing wiring systems, comply with existing color code when existing code complies with NFPA 70 and is approved by the authority having jurisdiction.

2.03 SINGLE CONDUCTOR BUILDING WIRE

- A. Manufacturers:
1. Copper Building Wire:
- B. Description: Single conductor insulated wire.
- C. Conductor Stranding:
1. Feeders and Branch Circuits:
 - a. Size 10 AWG and Smaller: Solid.
 - b. Size 8 AWG and Larger: Stranded.
- D. Insulation Voltage Rating: 600 V.
- E. Insulation:
1. Copper Building Wire: Type THHN/THWN or THHN/THWN-2, except as indicated below.

2.04 MANUFACTURED WIRING SYSTEMS

- A. Description: Manufactured wiring assemblies complying with NFPA 70 Article 604, and listed and labeled as complying with UL 183.
- B. Provide components necessary to transition between manufactured wiring system and other wiring methods.
- C. Branch Circuit Cables:
1. Conductor Stranding (Size 10 AWG and Smaller): Solid.
 2. Insulation Voltage Rating: 600 V.
 3. Insulation: Type THHN.
 4. Grounding: Full-size integral equipment grounding conductor.
 5. Armor: Steel, interlocked tape.
- D. Connectors: Keyed and color-coded to prevent interconnection of different voltages.
- E. Fixture Leads: Type TFN insulation.

2.05 WIRING CONNECTORS

- A. Description: Wiring connectors appropriate for the application, suitable for use with the conductors to be connected, and listed as complying with UL 486A-486B or UL 486C as applicable.
- B. Wiring Connectors for Splices and Taps:

2.06 ACCESSORIES

- A. Electrical Tape:
1. Vinyl Insulating Electrical Tape: Complying with ASTM D3005 and listed as complying with UL 510; minimum thickness of 7 mil (0.18 mm); resistant to abrasion, corrosion, and

sunlight; conformable for application down to 0 degrees F (-18 degrees C) and suitable for continuous temperature environment up to 221 degrees F (105 degrees C).

- B. Wire Pulling Lubricant:
 - 1. Listed and labeled as complying with UL 267.
 - 2. Suitable for use with conductors/cables and associated insulation/jackets to be installed.
 - 3. Suitable for use at installation temperature.
- C. Cable Ties: Material and tensile strength rating suitable for application.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that interior of building has been protected from weather.
- B. Verify that work likely to damage wire and cable has been completed.
- C. Verify that raceways, boxes, and equipment enclosures are installed and are properly sized to accommodate conductors and cables in accordance with NFPA 70.
- D. Verify that field measurements are as indicated.
- E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

- A. Clean raceways thoroughly to remove foreign materials before installing conductors and cables.

3.03 INSTALLATION

- A. Circuiting Requirements:
 - 1. Unless dimensioned, circuit routing indicated is diagrammatic.
 - 2. Maintain separation of Class 1, Class 2, and Class 3 remote-control, signaling, and power-limited circuits in accordance with NFPA 70.
 - 3. Maintain separation of wiring for emergency systems in accordance with NFPA 70.
 - 4. Circuiting Adjustments: Unless otherwise indicated, when branch circuits are indicated as separate, combining them together in a single raceway is not permitted.
 - a. Provide no more than six current-carrying conductors in a single raceway. Dedicated neutral conductors are considered current-carrying conductors.
 - 5. Common Neutrals: Unless otherwise indicated, sharing of neutral/grounded conductors among up to three single phase branch circuits of different phases installed in the same raceway is not permitted. Provide dedicated neutral/grounded conductor for each individual branch circuit.
- B. Install products in accordance with manufacturer's instructions.
- C. Perform work in accordance with NECA 1 (general workmanship).
- D. Installation in Raceway:
 - 1. Tape ends of conductors and cables to prevent infiltration of moisture and other contaminants.
 - 2. Pull all conductors and cables together into raceway at same time.
 - 3. Do not damage conductors and cables or exceed manufacturer's recommended maximum pulling tension and sidewall pressure.
 - 4. Use suitable wire pulling lubricant where necessary, except when lubricant is not recommended by the manufacturer.
- E. Paralleled Conductors: Install conductors of the same length and terminate in the same manner.
- F. Secure and support conductors and cables in accordance with NFPA 70 using suitable supports and methods approved by the authority having jurisdiction. Provide independent

support from building structure. Do not provide support from raceways, piping, ductwork, or other systems.

- G. Install conductors with a minimum of 12 inches (300 mm) of slack at each outlet.
- H. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.
- I. Group or otherwise identify neutral/grounded conductors with associated ungrounded conductors inside enclosures in accordance with NFPA 70.
- J. Make wiring connections using specified wiring connectors.
 - 1. Make splices and taps only in accessible boxes. Do not pull splices into raceways or make splices in conduit bodies or wiring gutters.
 - 2. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors.
 - 3. Do not remove conductor strands to facilitate insertion into connector.
 - 4. Clean contact surfaces on conductors and connectors to suitable remove corrosion, oxides, and other contaminants. Do not use wire brush on plated connector surfaces.
- K. Insulate splices and taps that are made with uninsulated connectors using methods suitable for the application, with insulation and mechanical strength at least equivalent to unspliced conductors.
- L. Insulate ends of spare conductors using vinyl insulating electrical tape.
- M. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.
- N. Unless specifically indicated to be excluded, provide final connections to all equipment and devices, including those furnished by others, as required for a complete operating system.

END OF SECTION

SECTION 26 05 26
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Grounding and bonding requirements.
- B. Conductors for grounding and bonding.
- C. Connectors for grounding and bonding.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables: Additional requirements for conductors for grounding and bonding, including conductor color coding.
- B. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

1.03 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.
- B. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- C. UL 467 - Grounding and Bonding Equipment; Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittals procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for grounding and bonding system components.
- C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.05 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.

PART 2 PRODUCTS

2.01 GROUNDING AND BONDING REQUIREMENTS

- A. Do not use products for applications other than as permitted by NFPA 70 and product listing.
- B. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.
- C. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

2.02 GROUNDING AND BONDING COMPONENTS

- A. General Requirements:
 - 1. Provide products listed, classified, and labeled as suitable for the purpose intended.
 - 2. Provide products listed and labeled as complying with UL 467 where applicable.
- B. Conductors for Grounding and Bonding, in Addition to Requirements of Section 26 05 26:
 - 1. Use insulated copper conductors unless otherwise indicated.
 - a. Exceptions:
 - 1) Use bare copper conductors where installed underground in direct contact with earth.

- 2) Use bare copper conductors where directly encased in concrete (not in raceway).
- C. Connectors for Grounding and Bonding:
 1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.
 2. Unless otherwise indicated, use exothermic welded connections for underground, concealed and other inaccessible connections.
 3. Unless otherwise indicated, use mechanical connectors, compression connectors, or exothermic welded connections for accessible connections.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that work likely to damage grounding and bonding system components has been completed.
- B. Verify that field measurements are as indicated.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Make grounding and bonding connections using specified connectors.
 1. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors. Do not remove conductor strands to facilitate insertion into connector.
 2. Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.
 3. Exothermic Welds: Make connections using molds and weld material suitable for the items to be connected in accordance with manufacturer's recommendations.
 4. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
 5. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.
- D. Identify grounding and bonding system components in accordance with Section 26 05 53.

END OF SECTION

**SECTION 26 05 29
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Support and attachment requirements and components for equipment, conduit, cable, boxes, and other electrical work.

1.02 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-in-Place Concrete: Concrete equipment pads.
- B. Section 26 05 33.13 - Conduit for Electrical Systems: Additional support and attachment requirements for conduits.
- C. Section 26 05 36 - Cable Trays for Electrical Systems: Additional support and attachment requirements for cable tray.
- D. Section 26 05 33.16 - Boxes for Electrical Systems: Additional support and attachment requirements for boxes.
- E. Section 26 51 00 - Interior Lighting: Additional support and attachment requirements for interior luminaires.

1.03 REFERENCE STANDARDS

- A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2024.
- B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.
- C. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2023.
- D. MFMA-4 - Metal Framing Standards Publication; 2004.
- E. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.
- F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate sizes and arrangement of supports and bases with actual equipment and components to be installed.
 - 2. Coordinate work to provide additional framing and materials required for installation.
 - 3. Coordinate compatibility of support and attachment components with mounting surfaces at installed locations.
 - 4. Coordinate arrangement of supports with ductwork, piping, equipment and other potential conflicts.
 - 5. Notify Architect of conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing:
 - 1. Do not install products on or provide attachment to concrete surfaces until concrete has cured; see Section 03 30 00.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

1.06 QUALITY ASSURANCE

- A. Maintain at project site one copy of each referenced document that prescribes execution requirements.

PART 2 PRODUCTS

2.01 SUPPORT AND ATTACHMENT COMPONENTS

- A. General Requirements:
 - 1. Comply with the following. Where requirements differ, comply with most stringent.
 - a. NFPA 70.
 - b. Requirements of authorities having jurisdiction.
 - 2. Provide required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for complete installation of electrical work.
 - 3. Provide products listed, classified, and labeled as suitable for purpose intended, where applicable.
 - 4. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for load to be supported with minimum safety factor of _____. Include consideration for vibration, equipment operation, and shock loads where applicable.
 - 5. Do not use products for applications other than as permitted by NFPA 70 and product listing.
 - 6. Steel Components: Use corrosion-resistant materials suitable for environment where installed.
 - a. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
 - b. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.
- B. Conduit and Cable Supports: Straps and clamps suitable for conduit or cable to be supported.
 - 1. Conduit Straps: One-hole or two-hole type; steel or malleable iron.
 - 2. Conduit Clamps: Bolted type unless otherwise indicated.
- C. Outlet Box Supports: Hangers and brackets suitable for boxes to be supported.
- D. Metal Channel/Strut Framing Systems:
 - 1. Description: Factory-fabricated, continuous-slot, metal channel/strut and associated fittings, accessories, and hardware required for field assembly of supports.
 - 2. Comply with MFMA-4.
- E. Hanger Rods: Threaded, zinc-plated steel unless otherwise indicated.
- F. Anchors and Fasteners:
 - 1. Unless otherwise indicated and where not otherwise restricted, use anchor and fastener types indicated for specified applications.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that mounting surfaces are ready to receive support and attachment components.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install hangers and supports in accordance with NECA 1.
- C. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
- D. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.

- E. Unless specifically indicated or approved by Architect, do not provide support from roof deck.
- F. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
- G. Equipment Support and Attachment:
 - 1. Use metal, fabricated supports or supports assembled from metal channel/strut to support equipment as required.
 - 2. Use metal channel/strut secured to studs to support equipment surface mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
 - 3. Use metal channel/strut to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
 - 4. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.
- H. Secure fasteners in accordance with manufacturer's recommended torque settings.
- I. Remove temporary supports.

END OF SECTION

SECTION 26 05 33.13
CONDUIT FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 RELATED REQUIREMENTS

- A. Section 07 84 00 - Firestopping.
- B. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables: Cable assemblies consisting of conductors protected by integral metal armor.
- C. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
 - 1. Includes additional requirements for fittings for grounding and bonding.
- D. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- E. Section 26 05 33.16 - Boxes for Electrical Systems.
- F. Section 26 05 33.23 - Surface Raceways for Electrical Systems.
- G. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

1.02 REFERENCE STANDARDS

- A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC); 2020.
- B. ANSI C80.3 - American National Standard for Electrical Metallic Tubing -- Steel (EMT-S); 2020.
- C. ANSI C80.6 - American National Standard for Electrical Intermediate Metal Conduit; 2018.
- D. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.
- E. NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT); 2020.
- F. NECA 111 - Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC); 2025.
- G. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; 2014.
- H. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- I. UL 6 - Electrical Rigid Metal Conduit-Steel; Current Edition, Including All Revisions.
- J. UL 360 - Liquid-Tight Flexible Metal Conduit; Current Edition, Including All Revisions.
- K. UL 514B - Conduit, Tubing, and Cable Fittings; Current Edition, Including All Revisions.
- L. UL 797 - Electrical Metallic Tubing-Steel; Current Edition, Including All Revisions.
- M. UL 797A - Electrical Metallic Tubing - Aluminum and Stainless Steel; Current Edition, Including All Revisions.
- N. UL 1242 - Electrical Intermediate Metal Conduit-Steel; Current Edition, Including All Revisions.
- O. UL 1660 - Liquid-Tight Flexible Nonmetallic Conduit; Current Edition, Including All Revisions.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate minimum sizes of conduits with actual type and quantity of conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
 - 2. Coordinate arrangement of conduits with structural members, ductwork, piping, equipment, and other potential conflicts.
 - 3. Verify exact conduit termination locations required for boxes, enclosures, and equipment.
 - 4. Coordinate work to provide roof penetrations that preserve integrity of roofing system and do not void roof warranty.

5. Notify Architect of conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing:
 1. Do not begin installation of conductors and cables until installation of conduit between termination points is complete.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittals procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conduits and fittings.

1.05 QUALITY ASSURANCE

- A. Documents at Project Site: Maintain at project site one copy of manufacturer's instructions and shop drawings.

PART 2 PRODUCTS

2.01 CONDUIT APPLICATIONS

- A. Do not use conduit and associated fittings for applications other than as permitted by NFPA 70, manufacturer's instructions, and product listing.
- B. Unless otherwise indicated and where not otherwise restricted, use conduit types indicated for specified applications. Where more than one listed application applies, comply with most restrictive requirements. Where conduit type for particular application is not specified, use galvanized steel rigid metal conduit.
- C. Concealed Above Accessible Ceilings: Use galvanized steel rigid metal conduit (RMC), stainless steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), stainless steel intermediate metal conduit (IMC), galvanized steel electrical metallic tubing (EMT), or stainless steel electrical metallic tubing (EMT).
- D. Interior, Damp or Wet Locations: Use galvanized steel rigid metal conduit (RMC), stainless steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), stainless steel intermediate metal conduit (IMC), galvanized steel electrical metallic tubing (EMT), or stainless steel electrical metallic tubing (EMT).
- E. Exposed, Interior, Not Subject to Physical Damage: Use galvanized steel rigid metal conduit (RMC), stainless steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), stainless steel intermediate metal conduit (IMC), galvanized steel electrical metallic tubing (EMT), or stainless steel electrical metallic tubing (EMT).
- F. Exposed, Interior, Subject to Physical Damage: Use galvanized steel rigid metal conduit (RMC), stainless steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), stainless steel intermediate metal conduit (IMC), galvanized steel electrical metallic tubing (EMT), or stainless steel electrical metallic tubing (EMT).

2.02 CONDUIT - GENERAL REQUIREMENTS

- A. Comply with NFPA 70.
- B. Existing Work: Where existing conduits are indicated to be reused, they may be reused only where they comply with specified requirements, are free from corrosion, and integrity is verified by pulling mandrel through them.
- C. Fittings for Grounding and Bonding: See Section 26 05 26 for additional requirements.
- D. Provide conduit, fittings, supports, and accessories required for complete raceway system.
- E. Provide products listed, classified, and labeled as suitable for purpose intended.
- F. Minimum Conduit Size, Unless Otherwise Indicated:
 1. Branch Circuits: 1/2-inch (16 mm) trade size.

2. Branch Circuit Homeruns: 3/4-inch (21 mm) trade size.
 3. Control Circuits: 1/2-inch (16 mm) trade size.
 4. Flexible Connections to Luminaires: 3/8-inch (12 mm) trade size.
- G. Where conduit size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

2.03 GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

- A. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6.
- B. Fittings:
1. Nonhazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B or UL 6.
 2. Material: Use steel or malleable iron.
 3. Connectors and Couplings: Use threaded type fittings only. Threadless fittings, including set screw and compression/gland types, are not permitted.

2.04 GALVANIZED STEEL INTERMEDIATE METAL CONDUIT (IMC)

- A. Description: NFPA 70, Type IMC galvanized steel intermediate metal conduit complying with ANSI C80.6 and listed and labeled as complying with UL 1242.
- B. Fittings:
1. Nonhazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B or UL 1242.
 2. Material: Use steel or malleable iron.
 3. Connectors and Couplings: Use threaded type fittings only. Threadless fittings, including set screw and compression/gland types, are not permitted.

2.05 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

- A. Description: NFPA 70, Type LFMC polyvinyl chloride (PVC) jacketed steel flexible metal conduit listed and labeled as complying with UL 360.
- B. Fittings:
1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 2. Material: Use steel or malleable iron.

2.06 GALVANIZED STEEL ELECTRICAL METALLIC TUBING (EMT)

- A. Description: NFPA 70, Type EMT galvanized steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.
- B. Fittings:
1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 2. Material: Use steel or malleable iron.
 3. Connectors and Couplings: Use compression/gland or set-screw type.
 - a. Do not use indenter type connectors and couplings.

2.07 ALUMINUM ELECTRICAL METALLIC TUBING (EMT)

- A. Description: NFPA 70, Type EMT aluminum electrical metallic tubing listed and labeled as complying with UL 797A.
- B. Fittings:
1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B; listed for use with aluminum EMT.
 2. Material: Use aluminum.
 3. Connectors and Couplings: Use compression/gland or set-screw type.

- a. Do not use indenter type connectors and couplings.

2.08 LIQUIDTIGHT FLEXIBLE NONMETALLIC CONDUIT (LFNC)

- A. Description: NFPA 70, Type LFNC liquidtight flexible nonmetallic conduit listed and labeled as complying with UL 1660.
- B. Fittings:
 - 1. Manufacturer: Same as manufacturer of conduit to be connected.
 - 2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B; suitable for type of conduit to be connected.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install conduit in accordance with NECA 1.
- C. Galvanized Steel Rigid Metal Conduit (RMC): Install in accordance with NECA 101.
- D. Intermediate Metal Conduit (IMC): Install in accordance with NECA 101.
- E. Liquidtight Flexible Nonmetallic Conduit (LFNC): Install in accordance with NECA 111.
- F. Conduit Routing:
 - 1. Conceal conduits unless specifically indicated to be exposed.
 - 2. Conduits in the following areas may be exposed, unless otherwise indicated:
 - a. Mechanical equipment rooms.
 - b. Within joists in areas with no ceiling.
 - 3. Unless otherwise approved, do not route exposed conduits:
 - a. Across floors.
 - b. Across roofs.
 - c. Across top of parapet walls.
 - d. Across building exterior surfaces.
 - 4. Conduits installed underground or embedded in concrete may be routed in shortest possible manner unless otherwise indicated. Route other conduits parallel or perpendicular to building structure and surfaces, following surface contours where practical.
 - 5. Arrange conduit to maintain adequate headroom, clearances, and access.
 - 6. Arrange conduit to provide no more than equivalent of four 90-degree bends between pull points.
 - 7. Arrange conduit to provide no more than 150 feet (46 m) between pull points.
 - 8. Route conduits above water and drain piping where possible.
 - 9. Arrange conduit to prevent moisture traps. Provide drain fittings at low points and at sealing fittings where moisture may collect.
 - 10. Maintain minimum clearance of 6 inches (150 mm) between conduits and piping for other systems.
 - 11. Maintain minimum clearance of 12 inches (300 mm) between conduits and hot surfaces. This includes, but is not limited to:
 - a. Heaters.
 - b. Flues.
- G. Conduit Support:
 - 1. Secure and support conduits in accordance with NFPA 70 using suitable supports and methods approved by authorities having jurisdiction; see Section 26 05 29.
 - 2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
 - 3. Use conduit strap to support single surface-mounted conduit.

- a. Use clamp back spacer with conduit strap for damp and wet locations to provide space between conduit and mounting surface.
4. Use of wire for support of conduits is not permitted.
- H. Connections and Terminations:
 1. Use approved zinc-rich paint or conduit joint compound on field-cut threads of galvanized steel conduits prior to making connections.
 2. Where two threaded conduits must be joined and neither can be rotated, use three-piece couplings or split couplings. Do not use running threads.
 3. Use suitable adapters where required to transition from one type of conduit to another.
 4. Provide drip loops for liquidtight flexible conduit connections to prevent drainage of liquid into connectors.
 5. Terminate threaded conduits in boxes and enclosures using threaded hubs or double lock nuts for dry locations and raintight hubs for wet locations.
 6. Provide insulating bushings, insulated throats, or listed metal fittings with smooth, rounded edges at conduit terminations to protect conductors.
 7. Secure joints and connections to provide mechanical strength and electrical continuity.
- I. Penetrations:
 1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.
 2. Make penetrations perpendicular to surfaces unless otherwise indicated.
 3. Provide sleeves for penetrations as indicated or as required to facilitate installation. Set sleeves flush with exposed surfaces unless otherwise indicated or required.
 4. Conceal bends for conduit risers emerging above ground.
 5. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.
 6. Make penetrations for roof-mounted equipment within associated equipment openings and curbs where possible to minimize roofing system penetrations. Where penetrations are necessary, seal as indicated or as required to preserve integrity of roofing system and maintain roof warranty.
 7. Install firestopping to preserve fire resistance rating of partitions and other elements; see Section 07 84 00.
- J. Conduit Movement Provisions: Where conduits are subject to movement, provide expansion and expansion/deflection fittings to prevent damage to enclosed conductors or connected equipment. This includes, but is not limited to:
 1. Where conduits cross structural joints intended for expansion, contraction, or deflection.
 2. Where conduits are subject to earth movement by settlement or frost.
- K. Conduit Sealing:
 1. Use foam conduit sealant to prevent entry of moisture and gases. This includes, but is not limited to:
 - a. Where conduits enter building from outside.
 - b. Where service conduits enter building from underground distribution system.
 - c. Where conduits enter building from underground.
 - d. Where conduits may transport moisture to contact live parts.
 2. Where conduits cross barriers between areas of potential substantial temperature differential, use foam conduit sealant at accessible point near penetration to prevent condensation. This includes, but is not limited to:
 - a. Where conduits pass from outdoors into conditioned interior spaces.
 - b. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.
- L. Provide grounding and bonding; see Section 26 05 26.

3.02 CLEANING

- A. Clean interior of conduits to remove moisture and foreign matter.

3.03 PROTECTION

- A. Immediately after installation of conduit, use suitable manufactured plugs to provide protection from entry of moisture and foreign material and do not remove until ready for installation of conductors.

END OF SECTION

SECTION 26 05 33.16
BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Outlet and device boxes up to 100 cubic inches (1,650 cu cm), including those used as junction and pull boxes.
- B. Cabinets and enclosures, including junction and pull boxes larger than 100 cubic inches (1,650 cu cm).
- C. Boxes and enclosures for integrated power, data, and audio/video.
- D. Boxes for hazardous (classified) locations.
- E. Floor boxes.

1.02 RELATED REQUIREMENTS

- A. Section 08 31 00 - Access Doors and Panels: Panels for maintaining access to concealed boxes.
- B. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- C. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- D. Section 26 05 33.13 - Conduit for Electrical Systems:
 - 1. Conduit bodies and other fittings.
- E. Section 26 05 33.23 - Surface Raceways for Electrical Systems:
- F. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- G. Section 26 27 26 - Wiring Devices:
 - 1. Wall plates.
 - 2. Floor box service fittings.

1.03 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.
- B. NECA 130 - Standard for Installing and Maintaining Wiring Devices; 2016.
- C. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.
- D. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; 2014.
- E. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports; 2013 (Reaffirmed 2020).
- F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- G. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.
- H. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.
- I. UL 508A - Industrial Control Panels; Current Edition, Including All Revisions.
- J. UL 514A - Metallic Outlet Boxes; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:

1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Coordinate minimum sizes of boxes with the actual installed arrangement of conductors, clamps, support fittings, and devices, calculated according to NFPA 70.
4. Coordinate minimum sizes of pull boxes with the actual installed arrangement of connected conduits, calculated according to NFPA 70.
5. Coordinate the placement of boxes with millwork, furniture, devices, equipment, etc. installed under other sections or by others.
6. Coordinate the work with other trades to preserve insulation integrity.
7. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted boxes where indicated.
8. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for cabinets and enclosures, boxes for hazardous (classified) locations, floor boxes, and underground boxes/enclosures.
- C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.06 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 BOXES

- A. General Requirements:
 1. Do not use boxes and associated accessories for applications other than as permitted by NFPA 70 and product listing.
 2. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.
 3. Provide products listed, classified, and labeled as suitable for the purpose intended.
 4. Where box size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
 5. Provide grounding terminals within boxes where equipment grounding conductors terminate.
- B. Outlet and Device Boxes Up to 100 cubic inches (1,650 cu cm), Including Those Used as Junction and Pull Boxes:
 1. Use sheet-steel boxes for dry locations unless otherwise indicated or required.
 2. Use cast iron boxes or cast aluminum boxes for damp or wet locations unless otherwise indicated or required; furnish with compatible weatherproof gasketed covers.
 3. Use suitable concrete type boxes where flush-mounted in concrete.

4. Use suitable masonry type boxes where flush-mounted in masonry walls.
 5. Use raised covers suitable for the type of wall construction and device configuration where required.
 6. Use shallow boxes where required by the type of wall construction.
 7. Do not use "through-wall" boxes designed for access from both sides of wall.
 8. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.
 9. Cast Metal Boxes: Comply with NEMA FB 1, and list and label as complying with UL 514A; furnish with threaded hubs.
 10. Boxes for Supporting Luminaires and Ceiling Fans: Listed as suitable for the type and weight of load to be supported; furnished with fixture stud to accommodate mounting of luminaire where required.
 11. Boxes for Ganged Devices: Use multigang boxes of single-piece construction. Do not use field-connected gangable boxes unless specifically indicated or permitted.
 12. Wall Plates: Comply with Section 26 27 26.
- C. Cabinets and Enclosures, Including Junction and Pull Boxes Larger Than 100 cubic inches (1,650 cu cm):
1. Comply with NEMA EN 10250, and list and label as complying with UL 50 and UL 50E, or UL 508A.
 2. NEMA EN 10250 Environment Type, Unless Otherwise Indicated:
 3. Junction and Pull Boxes Larger Than 100 cubic inches (1,650 cu cm):
 - a. Provide screw-cover or hinged-cover enclosures unless otherwise indicated.
- D. Boxes and Enclosures for Integrated Power, Data, and Audio/Video: Size and configuration as indicated or as required with partitions to separate services; field-connected gangable boxes may be used.
- E. Floor Boxes:
1. Description: Floor boxes compatible with floor box service fittings provided in accordance with Section 26 27 26; with partitions to separate multiple services; furnished with all components, adapters, and trims required for complete installation.
 2. Manufacturer: Same as manufacturer of floor box service fittings.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install boxes in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards where mounting heights are not indicated.
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Provide separate boxes for emergency power and normal power systems.
- E. Box Locations:
 1. Locate boxes to be accessible. Provide access panels in accordance with Section 08 31 00 as required where approved by the Architect.
 2. Locate boxes as required for devices installed under other sections or by others.
 3. Locate boxes so that wall plates do not span different building finishes.
 4. Locate boxes so that wall plates do not cross masonry joints.
 5. Unless otherwise indicated, where multiple outlet boxes are installed at the same location at different mounting heights, install along a common vertical center line.
- F. Box Supports:

1. Secure and support boxes in accordance with NFPA 70 and Section 26 05 29 using suitable supports and methods approved by the authority having jurisdiction.
 2. Provide independent support from building structure except for cast metal boxes (other than boxes used for fixture support) supported by threaded conduit connections in accordance with NFPA 70. Do not provide support from piping, ductwork, or other systems.
- G. Install boxes plumb and level.
- H. Flush-Mounted Boxes:
1. Install boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that front edge of box or associated raised cover is not set back from finished surface more than 1/4 inch (6 mm) or does not project beyond finished surface.
 2. Install boxes in combustible materials such as wood so that front edge of box or associated raised cover is flush with finished surface.
 3. Repair rough openings around boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that there are no gaps or open spaces greater than 1/8 inch (3 mm) at the edge of the box.
- I. Install boxes as required to preserve insulation integrity.
- J. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.
- K. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.
- L. Close unused box openings.
- M. Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use.
- N. Provide grounding and bonding in accordance with Section 26 05 26.

3.02 CLEANING

- A. Clean interior of boxes to remove dirt, debris, plaster and other foreign material.

3.03 PROTECTION

- A. Immediately after installation, protect boxes from entry of moisture and foreign material until ready for installation of conductors.

END OF SECTION

SECTION 26 05 53
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 RELATED REQUIREMENTS

- A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables: Color coding for power conductors and cables 600 V and less; vinyl color coding electrical tape.
- B. Section 26 27 26 - Wiring Devices - Lutron: Device and wallplate finishes; factory pre-marked wallplates.

1.02 REFERENCE STANDARDS

- A. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- B. UL 969 - Marking and Labeling Systems; Current Edition, Including All Revisions.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Verify final designations for equipment, systems, and components to be identified prior to fabrication of identification products.
- B. Sequencing:
 - 1. Do not conceal items to be identified, in locations such as above suspended ceilings, until identification products have been installed.
 - 2. Do not install identification products until final surface finishes and painting are complete.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittals procedures.

PART 2 PRODUCTS

2.01 IDENTIFICATION REQUIREMENTS

- A. Identification for Equipment:
 - 1. Use identification nameplate to identify each piece of electrical distribution and control equipment and associated sections, compartments, and components.
 - a. Panelboards:
 - 1) Identify power source and circuit number. Include location when not within sight of equipment.
 - 2) Use typewritten circuit directory to identify load(s) served for panelboards with a door. Identify spares and spaces using pencil.
 - 3) For power panelboards without a door, use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.
 - b. Enclosed switches, circuit breakers, and motor controllers:
 - c. Enclosed Contactors:
 - 2. Emergency System Equipment:
 - a. Use identification nameplate or voltage marker to identify emergency system equipment in accordance with NFPA 70.
 - b. Use identification nameplate at each piece of service equipment to identify type and location of on-site emergency power sources.
 - 3. Use identification label to identify overcurrent protective devices for branch circuits serving fire alarm circuits. Identify with text "FIRE ALARM CIRCUIT".
- B. Identification for Conductors and Cables:
 - 1. Color Coding for Power Conductors 600 V and Less: Comply with Section 26 05 19.
 - 2. Use identification nameplate or identification label to identify color code for ungrounded and grounded power conductors inside door or enclosure at each piece of feeder or

branch-circuit distribution equipment when premises has feeders or branch circuits served by more than one nominal voltage system.

2.02 IDENTIFICATION NAMEPLATES AND LABELS

- A. Identification Nameplates:
 - 1. Materials:
 - a. Indoor Clean, Dry Locations: Use plastic nameplates.
 - 2. Plastic Nameplates: Two-layer or three-layer laminated acrylic or electrically non-conductive phenolic with beveled edges; minimum thickness of 1/16 inch (1.6 mm); engraved text.
 - 3. Mounting Holes for Mechanical Fasteners: Two, centered on sides for sizes up to 1 inch (25 mm) high; Four, located at corners for larger sizes.
- B. Identification Labels:
 - 1. Materials: Use self-adhesive laminated plastic labels; UV, chemical, water, heat, and abrasion resistant.
 - 2. Text: Use factory pre-printed or machine-printed text. Do not use handwritten text unless otherwise indicated.
- C. Format for Receptacle Identification:
 - 1. Minimum Size: 3/8 inch (10 mm) by 1.5 inches (38 mm).
 - 2. Legend: Power source and circuit number or other designation indicated.
 - 3. Text: All capitalized unless otherwise indicated.
 - 4. Minimum Text Height: 3/16 inch (5 mm).
 - 5. Color: Black text on clear background.
- D. Format for Fire Alarm Device Identification:
 - 1. Minimum Size: 3/8 inch (10 mm) by 1.5 inches (38 mm).
 - 2. Legend: Designation indicated and device zone or address.
 - 3. Text: All capitalized unless otherwise indicated.
 - 4. Minimum Text Height: 3/16 inch (5 mm).
 - 5. Color: Red text on white background.

2.03 VOLTAGE MARKERS

- A. Minimum Size:
- B. Legend:
- C. Color: Black text on orange background unless otherwise indicated.

2.04 WARNING SIGNS AND LABELS

- A. Comply with ANSI Z535.2 or ANSI Z535.4 as applicable.
- B. Warning Signs:
 - 1. Materials:
 - 2. Minimum Size: 7 by 10 inches (178 by 254 mm) unless otherwise indicated.
- C. Warning Labels:
 - 1. Materials: Use factory pre-printed or machine-printed self-adhesive polyester or self-adhesive vinyl labels; UV, chemical, water, heat, and abrasion resistant; produced using materials recognized to UL 969.
 - 2. Machine-Printed Labels: Use thermal transfer process printing machines and accessories recommended by label manufacturer.
 - 3. Minimum Size: 2 by 4 inches (51 mm by 102 mm) unless otherwise indicated.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.

- B. Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance. Unless otherwise indicated, locate products as follows:
 - 1. Surface-Mounted Equipment: Enclosure front.
 - 2. Flush-Mounted Equipment: Inside of equipment door.
 - 3. Free-Standing Equipment: Enclosure front; also enclosure rear for equipment with rear access.
 - 4. Elevated Equipment: Legible from the floor or working platform.
 - 5. Branch Devices: Adjacent to device.
 - 6. Interior Components: Legible from the point of access.
 - 7. Conductors and Cables: Legible from the point of access.
- C. Install identification products centered, level, and parallel with lines of item being identified.
- D. Secure nameplates to exterior surfaces of enclosures using stainless steel screws and to interior surfaces using self-adhesive backing or epoxy cement.
- E. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed.
- F. Mark all handwritten text, where permitted, to be neat and legible.

END OF SECTION

**SECTION 26 05 83
WIRING CONNECTIONS**

PART 1 GENERAL

1.01 RELATED REQUIREMENTS

- A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.
- B. Section 26 05 33.13 - Conduit for Electrical Systems.
- C. Section 26 05 33.16 - Boxes for Electrical Systems.
- D. Section 26 27 26 - Wiring Devices.

1.02 REFERENCE STANDARDS

- A. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Obtain and review shop drawings, product data, manufacturer's wiring diagrams, and manufacturer's instructions for equipment furnished under other sections.
 - 2. Determine connection locations and requirements.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide wiring device manufacturer's catalog information showing dimensions, configurations, and construction.

1.05 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Products: Listed, classified, and labeled as suitable for the purpose intended.

PART 3 EXECUTION

2.01 ELECTRICAL CONNECTIONS

- A. Make electrical connections in accordance with equipment manufacturer's instructions.
- B. Make conduit connections to equipment using flexible conduit. Use liquidtight flexible conduit with watertight connectors in damp or wet locations.
- C. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.
- D. Provide receptacle outlet to accommodate connection with attachment plug.
- E. Provide cord and cap where field-supplied attachment plug is required.
- F. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.
- G. Install disconnect switches, controllers, control stations, and control devices to complete equipment wiring requirements.
- H. Install terminal block jumpers to complete equipment wiring requirements.
- I. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.

END OF SECTION

SECTION 26 24 16 PANELBOARDS

PART 1 GENERAL

1.01 RELATED REQUIREMENTS

- A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- B. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

1.02 REFERENCE STANDARDS

- A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service; 2013e, with Amendments (2022).
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.
- C. NECA 407 - Standard for Installing and Maintaining Panelboards; 2015.
- D. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.
- E. NEMA PB 1 - Panelboards; 2011.
- F. NEMA PB 1.1 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 1000V or Less; 2023.
- G. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- H. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.
- I. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.
- J. UL 67 - Panelboards; Current Edition, Including All Revisions.
- K. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
 - 2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
 - 3. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted panelboards where indicated.
 - 4. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
 - 5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, overcurrent protective device arrangement and sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.

1. Include dimensioned plan and elevation views of panelboards and adjacent equipment with all required clearances indicated.
 2. Identify mounting conditions required for equipment seismic qualification.
- C. Manufacturer's equipment seismic qualification certification.

1.05 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store panelboards in accordance with manufacturer's instructions and NECA 407.
- B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- C. Handle carefully in accordance with manufacturer's written instructions to avoid damage to panelboard internal components, enclosure, and finish.

PART 2 PRODUCTS

2.01 PANELBOARDS - GENERAL REQUIREMENTS

- A. Provide products listed, classified, and labeled as suitable for the purpose intended.
- B. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
1. Altitude: Less than 6,600 feet (2,000 m).
 2. Ambient Temperature:
 - a. Panelboards Containing Circuit Breakers: Between 23 degrees F (-5 degrees C) and 104 degrees F (40 degrees C).
- C. Short Circuit Current Rating:
- D. Mains: Configure for top or bottom incoming feed as indicated or as required for the installation.
- E. Branch Overcurrent Protective Devices: Replaceable without disturbing adjacent devices.
- F. Bussing: Sized in accordance with UL 67 temperature rise requirements.
1. Provide solidly bonded equipment ground bus in each panelboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.
- G. Conductor Terminations: Suitable for use with the conductors to be installed.
- H. Enclosures: Comply with NEMA EN 10250, and list and label as complying with UL 50 and UL 50E.
1. Environment Type per NEMA EN 10250: Unless otherwise indicated, as specified for the following installation locations:
 2. Boxes: Galvanized steel unless otherwise indicated.
 - a. Provide wiring gutters sized to accommodate the conductors to be installed.
 3. Fronts:
 - a. Fronts for Surface-Mounted Enclosures: Same dimensions as boxes.
 - b. Fronts for Flush-Mounted Enclosures: Overlap boxes on all sides to conceal rough opening.
 4. Lockable Doors: All locks keyed alike unless otherwise indicated.
- I. Future Provisions: Prepare all unused spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.

2.02 POWER DISTRIBUTION PANELBOARDS

- A. Description: Panelboards complying with NEMA PB 1, power and feeder distribution type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.
- B. Conductor Terminations:
 - 1. Main and Neutral Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
 - 2. Main and Neutral Lug Type: Mechanical.
- C. Bussing:
 - 1. Phase and Neutral Bus Material: Aluminum.
 - 2. Ground Bus Material: Aluminum.
- D. Circuit Breakers:
 - 1. Provide bolt-on type or plug-in type secured with locking mechanical restraints.
- E. Enclosures:
 - 1. Provide surface-mounted enclosures unless otherwise indicated.

2.03 LIGHTING AND APPLIANCE PANELBOARDS

- A. Description: Panelboards complying with NEMA PB 1, lighting and appliance branch circuit type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.
- B. Conductor Terminations:
 - 1. Main and Neutral Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
 - 2. Main and Neutral Lug Type: Mechanical.
- C. Bussing:
 - 1. Phase Bus Connections: Arranged for sequential phasing of overcurrent protective devices.
 - 2. Phase and Neutral Bus Material: Aluminum.
 - 3. Ground Bus Material: Aluminum.
- D. Circuit Breakers: Thermal magnetic bolt-on type unless otherwise indicated.
- E. Enclosures:
 - 1. Provide surface-mounted or flush-mounted enclosures as indicated.
 - 2. Provide clear plastic circuit directory holder mounted on inside of door.

2.04 OVERCURRENT PROTECTIVE DEVICES

- A. Molded Case Circuit Breakers:
 - 1. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.
 - 2. Interrupting Capacity:
 - a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than:
 - b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
 - 3. Conductor Terminations:
 - a. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
 - 4. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
 - 5. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.

2.05 SOURCE QUALITY CONTROL

- A. Factory test panelboards according to NEMA PB 1.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Perform work in accordance with NECA 1 (general workmanship).
- B. Install products in accordance with manufacturer's instructions.
- C. Install panelboards in accordance with NECA 407 and NEMA PB 1.1.
- D. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- E. Provide required support and attachment in accordance with Section 26 05 29.
- F. Install panelboards plumb.
- G. Install flush-mounted panelboards so that trims fit completely flush to wall with no gaps and rough opening completely covered.
- H. Mount panelboards such that the highest position of any operating handle for circuit breakers or switches does not exceed 79 inches (2000 mm) above the floor or working platform.
- I. Provide minimum of six spare 1 inch (27 mm) trade size conduits out of each flush-mounted panelboard stubbed into accessible space above ceiling and below floor.
- J. Provide grounding and bonding in accordance with Section 26 05 26.
- K. Install all field-installed branch devices, components, and accessories.
- L. Provide filler plates to cover unused spaces in panelboards.

3.02 CLEANING

- A. Clean dirt and debris from panelboard enclosures and components according to manufacturer's instructions.
- B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION

SECTION 26 27 26 WIRING DEVICES

PART 1 GENERAL

1.01 RELATED REQUIREMENTS

- A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables: Manufactured wiring systems for use with access floor boxes with compatible pre-wired connectors.
- B. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- C. Section 26 05 33.16 - Boxes for Electrical Systems.
- D. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- E. Section 26 05 83 - Wiring Connections: Cords and plugs for equipment.

1.02 REFERENCE STANDARDS

- A. FS W-C-596 - Connector, Electrical, Power, General Specification for; 2014h (Validated 2022).
- B. FS W-S-896 - Switches, Toggle (Toggle and Lock), Flush Mounted (General Specification); 2017g (Validated 2023).
- C. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.
- D. NECA 130 - Standard for Installing and Maintaining Wiring Devices; 2016.
- E. NEMA WD 1 - General Color Requirements for Wiring Devices; 1999 (Reaffirmed 2020).
- F. NEMA WD 6 - Wiring Devices - Dimensional Specifications; 2021.
- G. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- H. UL 20 - General-Use Snap Switches; Current Edition, Including All Revisions.
- I. UL 498 - Attachment Plugs and Receptacles; Current Edition, Including All Revisions.
- J. UL 514D - Cover Plates for Flush-Mounted Wiring Devices; Current Edition, Including All Revisions.
- K. UL 943 - Ground-Fault Circuit-Interrupters; Current Edition, Including All Revisions.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the placement of outlet boxes with millwork, furniture, equipment, etc. installed under other sections or by others.
 - 2. Coordinate wiring device ratings and configurations with the electrical requirements of actual equipment to be installed.
 - 3. Coordinate the installation and preparation of uneven surfaces, such as split face block, to provide suitable surface for installation of wiring devices.
 - 4. Notify Architect of any conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations.

1.05 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Products: Listed, classified, and labeled as suitable for the purpose intended.

PART 2 PRODUCTS

2.01 WIRING DEVICES - GENERAL REQUIREMENTS

- A. Provide wiring devices suitable for intended use with ratings adequate for load served.
- B. Wiring Device Applications:
 - 1. Receptacles Installed Outdoors or in Damp or Wet Locations: Use weather-resistant GFCI receptacles with weatherproof covers.
 - 2. Provide GFCI protection for:
 - a. Receptacles serving electric drinking fountains.

2.02 WALL SWITCHES

- A. General Requirements: AC only, quiet operating, general-use snap switches with silver alloy contacts, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 20 and where applicable, FS W-S-896; types as indicated on the drawings.
 - 1. Wiring Provisions: Terminal screws for side wiring and screw actuated binding clamp for back wiring with separate ground terminal screw.

2.03 RECEPTACLES

- A. General Requirements: Self-grounding, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 498, and where applicable, FS W-C-596; types as indicated on the drawings.
 - 1. Wiring Provisions: Terminal screws for side wiring or screw actuated binding clamp for back wiring with separate ground terminal screw.
 - 2. NEMA configurations specified are according to NEMA WD 6.
- B. Convenience Receptacles:
 - 1. Weather Resistant Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as weather resistant type complying with UL 498 Supplement SD suitable for installation in damp or wet locations; single or duplex as indicated on the drawings.
- C. GFCI Receptacles:
 - 1. General Requirements: Self-testing, with feed-through protection and light to indicate ground fault tripped condition and loss of protection; listed as complying with UL 943, class A.

2.04 WALL PLATES AND COVERS

- A. Wall Plates: Comply with UL 514D.
 - 1. Configuration: One piece cover as required for quantity and types of corresponding wiring devices.
 - 2. Size: Standard; _____.
 - 3. Screws: Metal with slotted heads finished to match wall plate finish.
- B. Weatherproof Receptacle Covers for Wet Locations: Gasketed, cast aluminum, with hinged lockable cover and corrosion-resistant screws; listed as suitable for use in wet locations while in use with attachment plugs connected and identified as extra-duty type.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Perform work in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.
- B. Coordinate locations of outlet boxes provided under Section 26 05 33.16 as required for installation of wiring devices provided under this section.
 - 1. Mounting Heights: Unless otherwise indicated, as follows:
 - a. Wall Switches: 48 inches (1200 mm) above finished floor.

- b. Wall Dimmers: 48 inches (1200 mm) above finished floor.
- c. Receptacles: 18 inches (450 mm) above finished floor or 6 inches (150 mm) above counter.
- C. Install wiring devices in accordance with manufacturer's instructions.
- D. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.
- E. Where required, connect wiring devices using pigtails not less than 6 inches (150 mm) long. Do not connect more than one conductor to wiring device terminals.
- F. Connect wiring devices by wrapping conductor clockwise 3/4 turn around screw terminal and tightening to proper torque specified by the manufacturer. Where present, do not use push-in pressure terminals that do not rely on screw-actuated binding.
- G. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
- H. Install wiring devices plumb and level with mounting yoke held rigidly in place.
- I. Install wall switches with OFF position down.
- J. Install vertically mounted receptacles with grounding pole on top and horizontally mounted receptacles with grounding pole on left.
- K. Install wall plates to fit completely flush to wall with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.
- L. Install blank wall plates on junction boxes and on outlet boxes with no wiring devices installed or designated for future use.

3.02 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Inspect each wiring device for damage and defects.
- C. Operate each wall switch, wall dimmer, and fan speed controller with circuit energized to verify proper operation.
- D. Test each receptacle to verify operation and proper polarity.
- E. Test each GFCI receptacle for proper tripping operation according to manufacturer's instructions.
- F. Correct wiring deficiencies and replace damaged or defective wiring devices.

END OF SECTION

**SECTION 26 51 00
INTERIOR LIGHTING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Interior luminaires.
- B. Emergency lighting units.
- C. Exit signs.
- D. Ballasts and drivers.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- B. Section 26 05 33.16 - Boxes for Electrical Systems.
- C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

1.03 REFERENCE STANDARDS

- A. IES LM-79 - Approved Method: Optical and Electrical Measurements of Solid-State Lighting Products; 2024.
- B. IES LM-80 - Approved Method: Measuring Maintenance of Light Output Characteristics of Solid-State Light Sources; 2021.
- C. NECA/IESNA 500 - Standard for Installing Indoor Commercial Lighting Systems; 2025.
- D. NECA/IESNA 502 - Standard for Installing Industrial Lighting Systems; 2006.
- E. NEMA LE 4 - Recessed Luminaires, Ceiling Compatibility; 2023.
- F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- G. NFPA 101 - Life Safety Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- H. UL 924 - Emergency Lighting and Power Equipment; Current Edition, Including All Revisions.
- I. UL 1598 - Luminaires; Current Edition, Including All Revisions.
- J. UL 8750 - Light Emitting Diode (LED) Equipment for Use in Lighting Products; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the installation of luminaires with mounting surfaces installed under other sections or by others. Coordinate the work with placement of supports, anchors, etc. required for mounting. Coordinate compatibility of luminaires and associated trims with mounting surfaces at installed locations.
 - 2. Coordinate the placement of luminaires with structural members, ductwork, piping, equipment, diffusers, fire suppression system components, and other potential conflicts installed under other sections or by others.
 - 3. Coordinate the placement of exit signs with furniture, equipment, signage or other potential obstructions to visibility installed under other sections or by others.
 - 4. Notify Architect of any conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

- B. Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting requirements, listings, service conditions, photometric performance, installed accessories, and ceiling compatibility; include model number nomenclature clearly marked with all proposed features.
 - 1. LED Luminaires:
 - a. Include estimated useful life, calculated based on IES LM-80 test data.

1.06 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.

1.07 DELIVERY, STORAGE, AND PROTECTION

- A. Receive, handle, and store products according to NECA/IESNA 500 (commercial lighting), NECA/IESNA 502 (industrial lighting), and manufacturer's written instructions.
- B. Keep products in original manufacturer's packaging and protect from damage until ready for installation.

1.08 FIELD CONDITIONS

- A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.09 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. Provide 3-year manufacturer warranty for LED luminaires, including drivers.
- C. Provide 5-year pro-rata warranty for batteries for emergency lighting units.

PART 2 PRODUCTS

2.01 LUMINAIRE TYPES

- A. Furnish products as indicated in luminaire schedule included on the drawings.

2.02 LUMINAIRE TYPES

- A. Furnish products as specified below.
- B. Type ____ : Exit sign.
 - 1. Lamps: LED.
 - 2. Voltage: Dual 120/277 V.
 - 3. Provide with the following features/accessories:

2.03 LUMINAIRES

- A. Provide products that comply with requirements of NFPA 70.
- B. Provide products that are listed and labeled as complying with UL 1598, where applicable.
- C. Provide products listed, classified, and labeled as suitable for the purpose intended.
- D. Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, ballasts, reflectors, lenses, housings and other components required to position, energize and protect the lamp and distribute the light.
- E. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, supports, trims, accessories, etc. as necessary for a complete operating system.
- F. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.
- G. Recessed Luminaires:
 - 1. Ceiling Compatibility: Comply with NEMA LE 4.

- H. LED Luminaires:
 - 1. Components: UL 8750 recognized or listed as applicable.
 - 2. Tested in accordance with IES LM-79 and IES LM-80.
 - 3. LED Estimated Useful Life: Minimum of 50,000 hours at 70 percent lumen maintenance, calculated based on IES LM-80 test data.

2.04 EMERGENCY LIGHTING UNITS

- A. Description: Emergency lighting units complying with NFPA 101 and all applicable state and local codes, and listed and labeled as complying with UL 924.
- B. Operation: Upon interruption of normal power source or brownout condition exceeding 20 percent voltage drop from nominal, solid-state control automatically switches connected lamps to integral battery power for minimum of 90 minutes of rated emergency illumination, and automatically recharges battery upon restoration of normal power source.
- C. Battery:
 - 1. Size battery to supply all connected lamps, including emergency remote heads where indicated.
- D. Diagnostics: Provide power status indicator light and accessible integral test switch to manually activate emergency operation.
- E. Provide low-voltage disconnect to prevent battery damage from deep discharge.

2.05 EXIT SIGNS

- A. Description: Exit signs complying with NFPA 101 and applicable state and local codes, and listed and labeled as complying with UL 924.
 - 1. Number of Faces: Single- or double-face as indicated or as required for installed location.
 - 2. Directional Arrows: As indicated or as required for installed location.

2.06 BALLASTS AND DRIVERS

- A. Ballasts/Drivers - General Requirements:
 - 1. Provide ballasts containing no polychlorinated biphenyls (PCBs).
 - 2. Minimum Efficiency/Efficacy: Provide ballasts complying with all current applicable federal and state ballast efficiency/efficacy standards.
- B. Dimmable LED Drivers:
 - 1. Dimming Range: Continuous dimming from 100 percent to five percent relative light output unless dimming capability to lower level is indicated, without flicker.
 - 2. Control Compatibility: Fully compatible with the dimming controls to be installed.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate conductors in accordance with NFPA 70.
- C. Verify that suitable support frames are installed where required.
- D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to luminaires.
- E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Coordinate locations of outlet boxes provided under Section 26 05 33.16 as required for installation of luminaires provided under this section.
- B. Install products in accordance with manufacturer's instructions.

- C. Install luminaires securely, in a neat and workmanlike manner, as specified in NECA 500 (commercial lighting) and NECA 502 (industrial lighting).
- D. Provide required support and attachment in accordance with Section 26 05 29.
- E. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.
- F. Suspended Ceiling Mounted Luminaires:
 - 1. Do not use ceiling tiles to bear weight of luminaires.
 - 2. Do not use ceiling support system to bear weight of luminaires unless ceiling support system is certified as suitable to do so.
 - 3. Secure pendant-mounted luminaires to building structure.
 - 4. Secure lay-in luminaires to ceiling support channels using listed safety clips at four corners.
 - 5. See appropriate Division 9 section where suspended grid ceiling is specified for additional requirements.
- G. Recessed Luminaires:
 - 1. Install trims tight to mounting surface with no visible light leakage.
- H. Suspended Luminaires:
 - 1. Install using the suspension method indicated, with support lengths and accessories as required for specified mounting height.
- I. Install accessories furnished with each luminaire.
- J. Bond products and metal accessories to branch circuit equipment grounding conductor.
- K. Emergency Lighting Units:
- L. Exit Signs:
- M. Install lamps in each luminaire.

3.03 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Inspect each product for damage and defects.
- C. Operate each luminaire after installation and connection to verify proper operation.
- D. Test self-powered exit signs, emergency lighting units, and fluorescent emergency power supply units to verify proper operation upon loss of normal power supply.
- E. Correct wiring deficiencies and repair or replace damaged or defective products. Repair or replace excessively noisy ballasts as determined by Architect.

3.04 CLEANING

- A. Clean surfaces according to NECA 500 (commercial lighting), NECA 502 (industrial lighting), and manufacturer's instructions to remove dirt, fingerprints, paint, or other foreign material and restore finishes to match original factory finish.

3.05 PROTECTION

- A. Protect installed luminaires from subsequent construction operations.

3.06 ATTACHMENTS

- A. Luminaire cut sheets.

END OF SECTION

**SECTION 27 05 29
HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Support and attachment requirements and components for equipment, conduit, cable, boxes, and other communications work.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- B. Section 27 05 33.13 - Conduit for Communications Systems: Additional support and attachment requirements for conduits.

1.03 REFERENCE STANDARDS

- A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2024.
- B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.
- C. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2023.
- D. BICSI ITSIMM - Information Technology Systems Installation Methods Manual (ITSIMM), 8th Edition; 2022.
- E. BICSI N1 - Installation Practices for Telecommunications and ICT Cabling and Related Cabling Infrastructure, 1st Edition; 2019.
- F. MFMA-4 - Metal Framing Standards Publication; 2004.
- G. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.
- H. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- I. TIA-569 - Telecommunications Pathways and Spaces; 2019e, with Addendum (2022).

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate sizes and arrangement of supports and bases with actual equipment and components to be installed.
 - 2. Coordinate work to provide additional framing and materials required for installation.
 - 3. Coordinate compatibility of support and attachment components with mounting surfaces at installed locations.
 - 4. Coordinate arrangement of supports with ductwork, piping, equipment and other potential conflicts.
 - 5. Notify Architect of conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing:
 - 1. Do not install products on or provide attachment to concrete surfaces until concrete has cured; see Section 03 30 00.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for cable supports, channel/strut framing systems, nonpenetrating rooftop supports, and post-installed concrete/masonry anchors.

1.06 QUALITY ASSURANCE

- A. Maintain at project site one copy of each referenced document that prescribes execution requirements.
- B. Installer Qualifications for Powder-Actuated Fasteners: Certified by fastener system manufacturer with current operator's license.
- C. Installer Qualifications for Field Welding: See Section 05 50 00.
- D. Product Listing Organization Qualifications: Organization recognized by OSHA as Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 SUPPORT AND ATTACHMENT COMPONENTS

- A. General Requirements:
 - 1. Comply with the following. Where requirements differ, comply with most stringent.
 - a. TIA-569.
 - b. NFPA 70.
 - c. Requirements of authorities having jurisdiction.
 - 2. Provide required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for complete installation of communications work.
 - 3. Provide products listed, classified, and labeled as suitable for purpose intended, where applicable.
 - 4. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for load to be supported with minimum safety factor of _____. Include consideration for vibration, equipment operation, and shock loads where applicable.
 - 5. Do not use products for applications other than as permitted by NFPA 70 and product listing.
 - 6. Steel Components: Use corrosion-resistant materials suitable for environment where installed.
 - a. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
 - b. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.
- B. Conduit Supports: Straps and clamps suitable for conduit to be supported.
 - 1. Conduit Straps: One-hole or two-hole type; steel or malleable iron.
 - 2. Conduit Clamps: Bolted type unless otherwise indicated.
- C. Outlet Box Supports: Hangers and brackets suitable for boxes to be supported.
- D. Metal Channel/Strut Framing Systems:
 - 1. Description: Factory-fabricated, continuous-slot, metal channel/strut and associated fittings, accessories, and hardware required for field assembly of supports.
 - 2. Comply with MFMA-4.
- E. Hanger Rods: Threaded, zinc-plated steel unless otherwise indicated.
- F. Anchors and Fasteners:
 - 1. Unless otherwise indicated and where not otherwise restricted, use anchor and fastener types indicated for specified applications.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.

- B. Install hangers and supports in accordance with NECA 1, BICSI ITSIMM, and BICSI N1.
- C. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
- D. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.
- E. Unless specifically indicated or approved by Architect, do not provide support from roof deck.
- F. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
- G. Equipment Support and Attachment:
 - 1. Use metal, fabricated supports or supports assembled from metal channel/strut to support equipment as required.
 - 2. Use metal channel/strut secured to studs to support equipment surface mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
 - 3. Use metal channel/strut to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
 - 4. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.
- H. Secure fasteners in accordance with manufacturer's recommended torque settings.
- I. Remove temporary supports.

3.02 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements for additional requirements.
- B. Inspect support and attachment components for damage and defects.
- C. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
- D. Correct deficiencies and replace damaged or defective support and attachment components.

END OF SECTION

SECTION 27 05 36
CABLE TRAYS FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

1.02 RELATED REQUIREMENTS

- A. Section 27 05 29 - Hangers and Supports for Communications Systems.

1.03 REFERENCE STANDARDS

- A. ASTM A780/A780M - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings; 2020.
- B. BICSI ITSIMM - Information Technology Systems Installation Methods Manual (ITSIMM), 8th Edition; 2022.
- C. NEMA BI-50016 - Cable Tray Installation Guidelines; 2024.
- D. NEMA BI 50015 - Metal Cable Tray Systems; 2024.
- E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate arrangement of cable tray with structural members, ductwork, piping, equipment and other potential conflicts. Coordinate work to avoid installation of obstructions within cable tray required clearances.
 - 2. Coordinate arrangement of cable tray with dimensions and clearance requirements of actual products to be installed.
 - 3. Coordinate work with placement of supports and anchors required for mounting.
 - 4. Notify of conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Preinstallation Meeting: Convene one week prior to commencing work of this section; require attendance of affected installers. Review proposed routing, sequence of installation, and protection requirements for installed cable tray.
- C. Sequencing:
 - 1. Do not begin installation of cables until installation of associated cable tray run is complete.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for cable tray system components and accessories. Include dimensions, materials, fabrication details, finishes, and span/load ratings.
- C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.06 QUALITY ASSURANCE

- A. Comply with NFPA 70.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions and NEMA BI-50016, except do not store cable tray outdoors without cover as permitted in NEMA BI-50016.

- B. Handle products carefully to avoid damage to finish.

PART 2 PRODUCTS

2.01 CABLE TRAY SYSTEM - GENERAL REQUIREMENTS

- A. Provide new cable tray system consisting of required components, fittings, supports, and accessories, as necessary for complete system.
- B. Provide products listed, classified, and labeled as suitable for purpose intended.
- C. Do not use cable tray for applications other than as permitted by NFPA 70 and product listing/classification.
- D. Provide cable tray system and associated components suitable for use at indicated span/load ratings under service conditions at installed location.
- E. Unless otherwise indicated, specified span/load ratings are based on safety factor of 1.5 and working load only (i.e., no additional concentrated static load), with ratings for metal cable tray systems in accordance with NEMA BI 50015.
- F. Unless otherwise indicated, specified load/fill depths and inside widths are nominal values, with values for metal cable tray systems in accordance with NEMA BI 50015 including applicable allowable tolerances.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that work likely to damage cable tray system has been completed.
- B. Verify field measurements.
- C. Verify dimensions and span/load ratings of cable tray system components.
- D. Verify that mounting surfaces are ready to receive cable tray and associated supports.
- E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

- A. Modifications to Existing Cable Tray Systems: Remove inactive or abandoned cables from existing cable tray system.

3.03 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Unless otherwise indicated, arrange cable tray to be parallel or perpendicular to building lines.
- C. Arrange cable tray to provide required clearances and maintain cable access.
 - 1. Maintain minimum clearance of 3 inches (75 mm) between bottom of cable tray and top of suspended ceilings, unless otherwise indicated or required by authorities having jurisdiction.
- D. Install cable tray plumb and level, with sections aligned and with horizontal runs at specified elevation.
- E. Metal Wire Mesh/Basket Cable Tray: Field fabricate fittings in accordance with manufacturer's instructions, using only manufacturer-approved connectors classified for bonding.
 - 1. Inside Radius of Fittings: 12 inches (305 mm).
- F. Hot-Dip Galvanized After Fabrication (H.D.G.A.F.) Steel Cable Tray: After cutting, drilling, or deburring, use approved zinc-rich paint to repair finish in accordance with ASTM A780/A780M.
- G. Cable Tray Movement Provisions:
 - 1. Provide expansion fittings where cable tray is subject to movement, including but not limited to:
 - a. Where cable tray crosses structural joints intended for expansion.
 - b. Long straight cable tray runs in accordance with NEMA BI-50016.

2. Use expansion guides in lieu of hold-down clamps where prescribed in NEMA BI-50016.
 3. Set gaps for expansion fittings in accordance with NEMA BI-50016.
- H. Cable Provisions:
1. Use fixed barrier strips to maintain separation of cables as indicated and as required by NFPA 70.
 2. Use drop-out fittings or bushings where cables exit cable tray as required to maintain minimum cable bending radius.
 3. Use cable support fittings for long vertical cable tray runs with heavy cables.
- I. Provide end closures at unconnected ends of cable tray runs.
- J. Cable Tray Support:
1. Use manufacturer's recommended hangers and supports, located in accordance with NEMA BI-50016, BICSI ITSIMM, and manufacturer's requirements, but not exceeding specified span unless otherwise approved by Engineer. Provide required support and attachment where not furnished by cable tray manufacturer.
 2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
- K. Grounding and Bonding Requirements:
1. Install cable tray grounding in accordance with the following. Where requirements differ, comply with the most stringent.
 2. Provide suitable bonding conductor in each metal cable tray. Do not use cable tray as sole bonding conductor.
- L. Penetrations: Install firestopping to preserve fire resistance rating of building elements.
- M. Identification Requirements:
- N. Install cable tray covers where indicated and as follows:

3.04 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements for additional requirements.
- B. Inspect cable tray system for damage and defects.
- C. Correct deficiencies and replace damaged or defective cable tray system components.

3.05 ADJUSTING

- A. Adjust tightness of mechanical connections to manufacturer's recommended torque settings.

3.06 CLEANING

- A. Remove dirt and debris from cable tray.
- B. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.07 PROTECTION

- A. Protect cable tray system from subsequent construction operations.

END OF SECTION

**SECTION 28 46 00
FIRE DETECTION AND ALARM**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Fire alarm system and associated components, including control units, related equipment, initiating devices, and notification appliances.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables: For non-power-limited cables.
- B. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- C. Section 26 05 33.16 - Boxes for Electrical Systems.
- D. Section 26 05 36 - Cable Trays for Electrical Systems.

1.03 ABBREVIATIONS AND ACRONYMS

- A. AHJ: Authorities having jurisdiction.
- B. BAS: Building automation system.
- C. DMNS: Distributed mass notification system.
- D. ECS: Emergency communications system.
- E. EoL: End-of-line.
- F. EVACS: Emergency voice/audio communication systems.
- G. FACU: Fire alarm control unit.
- H. HVAC: Heating, ventilation, and air conditioning.
- I. IDC: Initiating device circuit.
- J. LAN: Local area network.
- K. MNS: Mass notification system.
- L. NAC: Notification appliance circuit.
- M. NPLFA: Non-power-limited fire alarm.
- N. PLFA: Power-limited fire alarm.
- O. SLC: Signaling line circuit.
- P. SOO: Sequence of operation.

1.04 REFERENCE STANDARDS

- A. 36 CFR 1191 - Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines; current edition.
- B. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.
- C. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.
- D. NECA 90 - Standard for Commissioning Building Electrical Systems; 2015.
- E. NECA 305 - Standard for Fire Alarm System Job Practices; 2018.
- F. NFPA 1 - Fire Code; 2024, with Errata.
- G. NFPA 3 - Standard for Commissioning of Fire Protection and Life Safety Systems; 2024.
- H. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

- I. NFPA 72 - National Fire Alarm and Signaling Code; Most Recent Edition Cited by Referring Code or Reference Standard.
- J. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2024.
- K. UL 864 - Control Units and Accessories for Fire Alarm Systems; Current Edition, Including All Revisions.

1.05 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate arrangement of equipment with dimensions and clearance requirements of actual equipment.
 - 2. Coordinate placement of devices and notification appliances with potential conflicts or view obstructions.
 - 3. Coordinate work to provide power for equipment at required locations (e.g., smoke dampers, type of actuators, line or local control transformer, zoning, grouping and circuit activations).
 - 4. Coordinate requirements for branch circuit protection, identification, and shunt trip if applicable.
 - 5. Coordinate reflected ceiling plans to avoid conflicting placements; maintain minimum diffuser and detector clearances as indicated.
 - 6. Coordinate submittals to confirm equipment and associated components are capable of indicated settings, and manufacturer documentation identifies required compatible product listings.
 - 7. Notify Architect of conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.06 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Evidence of designer qualifications.
- C. Comply with NFPA 72 chapter "Documentation," including noting names of installers, owners, and system classification information.
- D. Design Documents: Submit all information required for plan review and permitting by AHJ, including floor plans, riser diagrams, and description of operation.
 - 1. Copy (if any) of list of data required by AHJ.
 - 2. NFPA 72 "Record of Completion", filled out to extent known at time.
 - 3. Clear and concise description of operation, with input/output matrix similar to that shown in NFPA 72 Appendix A, and complete listing of software required.
 - 4. Manufacturer's detailed product data sheet for each component, including wiring diagrams, and circuit length limitations. Catalog pages and product descriptions include ratings, dimensions, finishes, service conditions, and included features.
 - 5. Certification by manufacturer of FACU that system design complies with Contract Documents.
 - 6. Certification by Contractor that system design complies with Contract Documents.
- E. Shop Drawings: Submit installation documentation required for plan review and permitting by AHJ, including floor plans showing locations of fire alarm system components, enlarged drawn to identified scale plan view, and riser diagrams.
 - 1. System zone boundaries and interfaces to fire safety systems.
 - 2. Show locations of components, circuits, and raceways; mark components with identifiers used in control unit programming.
 - 3. Include elevations and details of proposed equipment arrangements.
 - 4. Include system interconnection schematic riser diagram showing proposed and approved cable size and type; coordinated with floor plans and describing circuit class, survivability, and application specific information required by NFPA 72.

5. Include typical wiring diagrams for devices, notification appliances, remote indicators, annunciators, remote test stations, and EoL and power supervisory devices.
 6. Include requirements and control diagrams for interfacing with other systems.
 7. Circuit layouts; number, size, and type of raceways and conductors; conduit fill calculations; standby and spare capacity calculations; notification appliance circuit loop resistance and voltage drop calculations, including spare capacity.
 8. List of devices and notification appliances on each SLC, with spare capacity indicated.
 9. Manufacturer's detailed data sheet for each component, including wiring diagrams, installation instructions, and circuit length limitations.
 10. Description of power supplies; if secondary power is by battery include calculations demonstrating adequate battery power.
 11. Detailed drawing of graphic annunciators, displays, and interfaces.
 12. Certification by either FACU manufacturer or manufacturer of related equipment.
 13. Certification by FACU manufacturer that system design complies with Contract Documents.
 14. Certification by Contractor that system design complies with Contract Documents.
- F. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- G. Evidence of installer qualifications.
- H. Inspection and Test Reports:
1. Submit inspection and test plan prior to closeout demonstration.
 2. Submit documentation of satisfactory inspections and tests.
 3. Submit NFPA 72 "Inspection and Test," filled out.
- I. Operating and Maintenance Data: See Section 01 7800 for additional requirements; revise and resubmit until acceptable; have one set available during closeout demonstration:
1. Complete set of specified design documents, as approved by AHJ.
 2. Additional printed set of project record documents and closeout documents, bound or filed in same manuals.
 3. Contact information for firm that will be providing contract maintenance and trouble call-back service.
 4. List of recommended spare parts, tools, and instruments for testing.
 5. Replacement parts list with current prices, and source of supply.
 6. Detailed troubleshooting guide and large scale input/output matrix.
 7. Preventive maintenance, inspection, and testing schedule complying with NFPA 72; provide printed copy and computer format acceptable to Owner.
 8. Detailed but easy to read explanation of procedures require recording of system trouble events by qualified personnel, such as when routine testing is being conducted for fire drills and when entering into contracts for building renovations.
- J. Project Record Documents: See Section 01 7800 for additional requirements, have one set available during closeout demonstration:
1. Complete set of floor plans showing actual installed locations of components, conduit, and zones.
 2. "As installed" wiring and schematic diagrams, with final terminal identifications.
 3. "As programmed" operating sequences, including control events by device, and updated input/output chart.
- K. Closeout Documents:
1. Certification by manufacturer that system has been installed in compliance with manufacturer's installation requirements, is complete, and is in satisfactory operating condition.

2. NFPA 72 "Record of Completion," filled out completely and signed by installer and authorized representative of AHJ.

1.07 QUALITY ASSURANCE

- A. Designer Qualifications: NICET Level III (three) or Level IV (four) certified fire alarm technician or registered fire protection engineer, employed by FACU manufacturer, Contractor, or installer, with experience designing fire alarm systems in jurisdictional area of AHJ.
- B. Installer Qualifications: Firm with minimum three years documented experience installing fire alarm systems of specified type and providing contract maintenance service as regular part of their business.
 1. Authorized representative of FACU manufacturer; submit manufacturer's certification that installer is authorized; include name and title of manufacturer's representative making certification.
 2. Installer Personnel: At least two years of experience installing fire alarm systems.
 3. Supervisor: Level III (three) or Level IV (four) certified fire alarm technician; furnish name and address.
- C. Manufacturer Qualifications: Company specialized in manufacturing products specified in this section with at least three years of documented experience.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. See Section 01 74 19 - Construction Waste Management and Disposal for packaging waste requirements.
- B. Receive, inspect, handle, and store products in accordance with manufacturer's instructions and NECA 305.
- C. Handle carefully to avoid damage to internal components, enclosure, and finish.
- D. Store products in manufacturer's unopened packaging, keep dry and protect from damage until ready for installation.

1.09 FIELD CONDITIONS

- A. Maintain field conditions within manufacturer's required service conditions during and after installation.
- B. Do not exceed maximum ambient temperature requirements for batteries at any time, which reduces battery service life. Replace batteries exposed to temperatures in excess of manufacturer's requirements.
- C. Do not install or otherwise handle thermoplastic-insulated conductors at temperatures lower than 14 degrees F (minus 10 degrees C), unless otherwise permitted by manufacturer's instructions. When installation below this temperature is unavoidable, notify Architect and obtain direction before proceeding with work.

1.10 WARRANTY

- A. Fire Alarm Control Units and Accessory Equipment: Provide minimum 3-year manufacturer warranty covering repair or replacement due to defective materials or workmanship.
- B. Fire Alarm Manual Pull Stations: Provide minimum 1-year manufacturer warranty covering repair or replacement due to defective materials or workmanship.
- C. Fire Alarm System Detectors: Provide minimum 1-year year manufacturer warranty covering repair or replacement due to defective materials or workmanship.
- D. Fire Alarm System Notification Appliances: Provide minimum 1-year year manufacturer warranty covering repair or replacement due to defective materials or workmanship.

PART 2 PRODUCTS

2.01 FIRE ALARM SYSTEM

A. General Requirements:

1. Provide new fire alarm system complying with NFPA 70, NFPA 72, NFPA 90A, and consisting of required equipment, conduit, cabinets, outlet boxes, wiring, connectors, hardware, supports, accessories, components, software, and system programming as necessary for complete operating system that provides functional intent indicated.
2. Comply with the following; where requirements conflict, order of precedence of requirements is as listed:
 - a. 36 CFR 1191 and ADA Standards.
 - b. Requirements of AHJ.
 - c. Applicable local codes.
 - d. Contract Documents.
 - e. NFPA 72; "should" is mandatory; where conflicts between requirements require deviation, identify deviations clearly on design documents.
3. Fire Alarm System Products:
 - a. Listed, classified, and labeled as suitable for purpose intended.
 - b. Installation Environments: Provide products suitable for their respective indoor and outdoor applications.
4. Fire Alarm System Design Information:
 - a. Building Code: Comply with applicable building code.
 - 1) Principle Occupancy: As indicated on Architect code summary drawings.
 - 2) Principle Use: As indicated on Architect code summary drawings.
 - b. NFPA 72 Fire Alarm System Classification: Protected premises.
5. Provide fire alarm circuits in accordance with NFPA 70.
 - a. Comply with methods of interconnecting FACUs in accordance with NFPA 72 and NFPA 70.
 - b. Power Sources:
 - 1) Comply with requirements for power supplies of emergency systems in accordance with NFPA 70.
 - 2) Primary: Dedicated branch circuits from facility power distribution system.
 - 3) Secondary: Storage batteries with capacity to operate system for period specified by NFPA 72.
 - c. Wiring and Wiring Methods:
 - 1) General Requirements:
 - (a) Comply with requirements for wiring and wiring methods in accordance with NFPA 70.
 - (b) Conductors and Cables Installed Exposed in Spaces Used for Environmental Air (only where specifically permitted): Plenum-rated, listed and labeled as suitable for use in return air plenums.
 - (c) Special Occupancies: Comply with NFPA 70.
 - (d) Comply with NFPA 70 for wire and cable plenum, riser, general-purpose, limited-use, undercarpet, and underground applications.
 - 2) Fire Alarm Circuits:
 - (a) Comply with NFPA 70 for conditions and types required for multiconductor cable systems.
 - (b) Non-Power-Limited Fire Alarm (NPLFA) Circuits:
 - (1) Provide dedicated NPLFA non-GFCI branch circuits for fire alarm equipment and marked by red identification in accordance with NFPA 70.
 - (c) Power-Limited Fire Alarm (PLFA) Circuits:
 - (1) Provide identification for PLFA circuits in accordance with NFPA 70.
 6. Provide pathway class designations and pathway survivability, as defined in NFPA 72.

- a. Provide monitoring of conductors and other signaling channels for integrity and circuit performance.
- b. Pathway Class Designations:
 - 1) Unless otherwise indicated or required, pathways to meet the following requirements:
 - (a) SLCs: Class B (star, tee-tap, multi-tap, with no return).
 - (b) IDCs: Class B (daisy-chain with EoL resistor device installed at end of circuit).
 - (c) NACs: Class B (daisy-chain with EoL resistor device installed at end of circuit).
- B. Fire Alarm System Interfaces and Control Functions:
 - 1. UL 864 listed unless otherwise indicated.
 - 2. Descriptions below are intended to provide means for interface. See project SOOs, narrative, and input/output matrix for execution requirements.
 - 3. Provide initiating devices, interfaces, and control functions for emergency control function interfaces in accordance with NFPA 72.
 - 4. Provide monitoring of interconnected systems. Coordinate notification appliance alternate markings as indicated on drawings.

2.02 FIRE ALARM CONTROL UNITS AND RELATED EQUIPMENT

- A. Fire Alarm Control Units and Related Equipment: Listed and labeled as complying with UL 864.
- B. Provide cabinets and enclosures as indicated or as required to house system components.
- C. Fire Alarm Control Unit (FACU): Addressable.
 - 1. SLCs and IDCs: Configurable for Class B or Class A with additional modules.
 - 2. NACs: Integral and programmable with synchronization modules or cards as required.
 - 3. Power Supply: 120 VAC, 60 Hz, supplying necessary power for FACU.
 - 4. User-Interface: Touchscreen display for system interfacing and service mode settings, include password and user credentials; configurable for custom actions and incorporates historical event log.
 - 5. Support self-testing detector capability.
 - 6. Remote Annunciator Support: Up to 10.

2.03 FIRE ALARM SYSTEM INITIATING DEVICES

- A. General Requirements:
 - 1. Addressable Systems:
 - a. Addressable Devices: Individually identifiable by addressable FACU; suitable for connection to FACU SLCs.
 - b. Conventional/Nonaddressable Devices: Provide addressable interface modules as indicated or as required for connection to addressable FACU. Unless devices are explicitly permitted to be connected together as one zone, provide separate addressable monitoring point for each device in order to be individually identifiable by addressable FACU.
 - 2. Provide devices and associated accessories suitable for intended application and location to be installed. Unless otherwise indicated, use addressable devices and addressable interface modules only in clean, dry, indoor, nonhazardous locations.
 - 3. Surface-Mounted Devices: Provide manufacturer's accessory surface mount backboxes or suitable outlet/device box.
 - 4. Devices for Outdoor and Damp/Wet Locations: Weatherproof, suitable for outdoor use; provide manufacturer's accessory backboxes or enclosures in accordance with product listing.
 - 5. Devices for Hazardous/Classified Locations: Listed and labeled as suitable for classification of installed location.

2.04 FIRE ALARM SYSTEM NOTIFICATION APPLIANCES

- A. General Requirements:
 - 1. Provide signaling notification appliances listed for fire-protective service and intended operating mode, public or private; suitable for connection to FACU notification appliance circuits.
 - 2. Provide notification appliances and associated accessories suitable for intended application and location to be installed. Use notification appliances only according to listed mounting (e.g. ceiling, wall).
 - 3. Surface-Mounted Notification Appliances: Provide manufacturer's accessory surface mount backboxes or suitable outlet/device box.
 - 4. Exterior Notification:
 - a. In addition to required occupant notification, provide notification appliances on exterior of building.
 - 5. Notification Appliance Derating: Include device derating adjustments in accordance with listing where applicable, including the following.
 - a. Where accessory protective guards or enclosures are utilized.
 - b. Where required by field conditions (e.g., ambient temperature and sound).

2.05 ACCESSORIES

- A. Provide components as indicated or as required for connection of fire alarm system to devices and other systems indicated.
- B. Provide EoL resistors as required for wiring supervision.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that mounting surfaces are ready to accept components and equipment, with suitable support frames and anchors installed where required.
- B. Verify ratings, configurations, and characteristics of system components.
- C. Verify rough-ins for field connections.
- D. Verify that work likely to damage fire alarm system has been completed.
- E. Verify that interior of building has been protected from weather.
- F. Perform preinstallation tests and inspections per manufacturer's instructions and in accordance with NECA 305.
- G. Verify that system bonding is in accordance with Section 26 05 26.
- H. Do not energize system until deficiencies have been corrected.
- I. Verify that branch circuit wiring installation is completed, tested, and ready for connection to fire alarm system. Overcurrent protection ratings are consistent with circuit voltage and manufacturer's recommendations and nameplate data for equipment.

3.02 PREPARATION

- A. Prior to installation, confirm environment of installation area is clean, and with ambient temperature, humidity, and ventilation requirements are per manufacturer's written instructions.
 - 1. Clean and vacuum in accordance with manufacturer's written instructions. Confirm equipment ventilation holes are absent of obstructions and free for air flow.
 - 2. Clean pathways thoroughly to remove foreign materials before installing conductors and cables.
 - 3. Clean dirt, debris, plaster, and other foreign materials from equipment enclosures, cabinets, and outlet boxes.
 - 4. Clean surfaces to receive adhesive products according to manufacturer's instructions.

- B. Follow tool requirements for installation, including torquing adjustments, as listed in manufacturer documentation.
- C. Remove detector dust covers prior to system energization.

3.03 INSTALLATION

- A. Install field-devices, components, FACU and related equipment, and accessories in accordance with the following:
- B. Field Locations:
 - 1. Obtain Owner's approval of locations of devices and notification appliances before installation.
 - 2. Arrange equipment to provide minimum operational clearances and required maintenance access in accordance with manufacturer's instructions and NFPA 70.
 - 3. Conceal wiring, conduit, outlet boxes, and supports where installed in finished areas; maintain code-required access.
- C. Raceways and Supports:
 - 1. Coordinate locations of outlet boxes as required for installation. Only install boxes and equipment at locations based on application standards indicated in NFPA 72.
 - 2. Secure and support raceways at intervals complying with NFPA 70. Provide supports where vertical rise exceeds permissible limits.
 - 3. Install firestopping to preserve fire resistance rating of partitions and other elements.
- D. Wiring and Connections:
 - 1. Maintain separation of Class 1, Class 2, Class 3 remote-control, signaling, fire alarm circuits, and power-limited circuits in accordance with cable insulation class and NFPA 70.
 - 2. Maintain circuit pathway and class designations in accordance with NFPA 72 for configuration, separation, and survivability.
 - 3. Comply with permitted and not permitted installations for wires, cables, cable routing assemblies, communications circuits, and fire alarm circuits in accordance with NFPA 70.
 - 4. Secure and support conductors and cables in accordance with NFPA 70 using suitable supports and methods approved by AHJ. Provide independent support from building structure and suspended ceiling systems. Do not provide support from raceways, piping, ductwork, or other systems.
 - 5. Provide grounding and bonding in accordance with Section 26 05 26.
 - 6. Comply with manufacturer's minimum cable sizes or ratings.
 - 7. Do not exceed manufacturer's recommended maximum power, signal, or network cable lengths between components.
 - 8. Provide network wiring in accordance with NFPA 70.
 - 9. Neatly train and bundle conductors inside boxes, wireways, and cabinets.
 - 10. See manufacturer's instructions for batteries.
- E. Fire Alarm System Components:
 - 1. Install field-installed devices, components, relays, notification appliances, accessories, and when applicable EoL resistors.
 - a. Install wiring to supervisory devices and associated EoL resistors as required for supervision of hardwired connections
 - 2. Install Wall-Mounted Equipment: Assemble component hardware within (e.g., card bays, sub-bays, expansion bays, signal cards, other card frames, networking, signal transmission, application modules, tamper monitoring devices, interconnecting modules, and auxiliary power supplies), including space for required spare capacity, and configure settings.
 - 3. Install Interconnect Wiring: Connect system cabinets, install processor and cards, cabling, connectors, terminations, and bonding.
- F. Branch Power:

1. After installation confirmations, follow manufacturer instructions to connect branch circuit power cables to premises fire alarm system components; comply with NFPA 70.
 2. Where accessories require auxiliary power, provide control power source and monitoring as indicated or as required to complete installation.
 3. Install auxiliary power supplies, including indicated monitoring, and connections necessary for remote equipment.
- G. System Identification:
1. Identify devices, notification appliances, components, cables, and equipment in accordance with approved submittals. See Section 26 05 53.
 2. Confirm fire alarm system programming meets requirements of SOO and sub-system SOOs.
 3. Mark location of disconnecting means for NPFLA circuits.
 4. Coordinate to provide red branch power circuit protective devices or identify them accordingly as required by NFPA 72 and NFPA 70.
 5. Mark date of batteries installed on inside cover of panels and formal maintenance logs.
- H. Troubleshooting and Installer Checks:
1. Field test connectivity periodically during installation process to avoid unexpected troubleshooting.
 2. Check system operation for notification, FACU functions, circuit supervision, alarm initiating devices, supervisory initiating devices, dress panels/doors/covers, and programming before performing field tests.
- I. Fire Alarm System Tests:
1. Perform required tests of NFPA 72. Record measured values during operational checks.
 2. Confirm functional testing of fire alarm system is as indicated in Contract Documents.

3.04 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements for additional requirements.
- B. Provide services of manufacturer's authorized representation to observe installation and assist in inspection, testing, and adjusting. Include manufacturer's detailed testing procedures and field reports and with submittals.
- C. Provide equipment, two-way radios for testing personnel use, tools, and supplies required to accomplish inspection and testing.
- D. Notify Owner and Architect at least two weeks prior to scheduled inspections and tests.
- E. Inspect and test in accordance with manufacturer's instructions.
- F. Inspect wiring and components for damage and defects.
- G. Batteries and Power Supplies: Perform inspections and tests listed in manufacturer installation instructions.
- H. Perform additional requirements related to testing and inspection during system startup.
- I. Test for interface with other systems.
- J. Test shunt trips to verify operation.
- K. Correct defective work, adjust for operation, and retest until entire system complies with Contract Documents.
- L. Submit detailed reports indicated inspection and testing results, corrective actions taken, and as-found and final adjusted settings.

3.05 ADJUSTING

- A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

- B. Adjust initiating device and notification appliance settings to achieve desired operation as indicated in submittals.
- C. Measure power supply primary and secondary voltages, log values for records, and make appropriate adjustments.
- D. Adjust alignment of equipment covers and doors. Provide keys and spare keys to Owner.
- E. Reprint and reinstall damaged or misinstalled labels; maintain neat and square to installed location good workmanship - see NECA 1; maintain consistent placements for identification on products of similar type.
- F. Adjust devices or notification appliances and associated bases to be flush and level.
- G. Program system parameters according to requirements of Owner.

3.06 CLEANING

- A. See Section 01 70 00 - Execution and Closeout Requirements for additional requirements.
- B. See Section 01 74 19 - Construction Waste Management and Disposal for field-generated construction waste requirements.
- C. Check tightness of electrical connections. Replace damaged components and provide closure plates for vacant positions. Provide circuit directory updates for related power branch circuits.
- D. Clean and repair existing materials and equipment that remain or are indicated for reuse.
- E. Clean dirt, debris, plaster, and other foreign materials from outlet boxes and fire alarm system equipment and components.
- F. Clean fire alarm system equipment and components according to manufacturer's instructions and NECA 305.
- G. Clean surfaces and interiors of boxes and device cover plates in accordance with manufacturer's instructions to remove dirt, fingerprints, debris, plaster, and other foreign materials.
- H. Repair scratched or marred exposed surfaces to match original factory finish.
- I. Comply with federal (EPA), state, and local regulations for battery handling and disposal. Do not spill battery fluids down plumbing drains. Only use containers safe for transportation marked 'nonspillable.'

3.07 COMMISSIONING

- A. See Section 01 91 13 - General Commissioning Requirements for additional requirements.
- B. Comply with NFPA 3 for commissioning of fire protection and life safety systems.
- C. Comply with NECA 90 for commissioning building electrical systems.
- D. Support Commissioning Agent in assembling test data and generating reports.
- E. Participate in four hours of seasonal testing, as scheduled by Commissioning Agent, six months from Date of Substantial Completion.

3.08 INSPECTION AND TESTING FOR COMPLETION

- A. Notify Owner 7 days prior to beginning completion inspections and tests.
- B. Notify AHJ and comply with their requirements for scheduling inspections and tests and for observation by their personnel.
- C. Provide services of installer's supervisor or person with equivalent qualifications to supervise inspection and testing, correction, and adjustments.
- D. Prepare for testing by ensuring that work is complete and correct; perform preliminary tests as required.

- E. Provide tools, software, and supplies required to accomplish inspection, testing, and document results.
- F. Perform inspection and testing in accordance with NFPA 72 and requirements of AHJ; document each inspection and test.
- G. Correct defective work, adjust for operation, and retest until entire system complies with Contract Documents.

3.09 CLOSEOUT ACTIVITIES

- A. See Section 01 78 00 - Closeout Submittals for additional submittals.
- B. See Section 01 79 00 - Demonstration and Training for additional requirements.
- C. Closeout Demonstration: Demonstrate operation of all functions to Owner.
 - 1. Be prepared to conduct any of required tests.
 - 2. Have minimum one copy of operation and maintenance data, preliminary copy of project record drawings, input/output matrix, and operator instruction chart(s) available during demonstration.
 - 3. Have authorized technical representative of FACU manufacturer present during demonstration.
 - 4. Demonstration may be combined with inspection and testing required by AHJ; notify AHJ with enough time to schedule demonstration.
 - 5. Repeat demonstration until successful.

END OF SECTION

**SECTION 33 05 61
CONCRETE MANHOLES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Precast concrete manholes.
- B. Grade adjustments.

1.02 REFERENCE STANDARDS

- A. AASHTO HB - Standard Specifications for Highway Bridges; 2005, with Errata.
- B. ASTM C270 - Standard Specification for Mortar for Unit Masonry; 2025a.
- C. ASTM C478/C478M - Standard Specification for Circular Precast Reinforced Concrete Manhole Sections; 2020.
- D. ASTM C990 - Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants; 2009 (Reapproved 2019).

1.03 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

PART 2 PRODUCTS

2.01 CONCRETE MANHOLES

- A. Weight Rating: H 10 according to AASHTO HB.
- B. Precast Concrete Manholes: Comply with ASTM C478/C478M, reinforced.
 - 1. Wall Thickness: 6 inches (152 mm).
 - 2. Base Thickness: 12 inches (305 mm).
 - 3. Reinforcement: Formed steel wire, galvanized finish, wire diameter as indicated on drawings.
 - 4. Joint Sealant: Comply with ASTM C990.
- C. Grade Adjustments:
 - 1. Adjustment Ring: Concrete, 6 inches (152 mm) wide, diameter matching frame dimensions, in accordance with ASTM C478/C478M.
- D. Mortar Mixing:
 - 1. Thoroughly mix mortar ingredients using mechanical batch mixer, in accordance with ASTM C270 and in quantities needed for immediate use.
 - 2. Maintain sand uniformly damp immediately before the mixing process.
 - 3. Do not use antifreeze compounds to lower the freezing point of mortar.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify items provided by other sections of work are properly sized and located.
- B. Verify that built-in items are in proper location, and ready for roughing into Work.
- C. Verify excavation for manholes is correct.

3.02 PREPARATION

- A. Coordinate placement of inlet and outlet pipe or duct sleeves required by other sections.

3.03 EXCAVATION AND FILL

- A. Hand trim excavation for accurate placement to indicated elevations.
- B. Backfill with cover fill, tamp in place and compact, then complete backfilling.

3.04 INSTALLATION

- A. Establish elevations and pipe inverts for inlets and outlets as indicated in drawings.
- B. Precast Concrete Manholes:
 - 1. Place base section plumb and level.
 - 2. Install joint sealant uniformly around section lip.
 - 3. Overlay additional sections on joint sealant.
- C. Grade Adjustments:
 - 1. Place adjacent materials tight, and smooth following design grades.

3.05 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements for additional requirements.
- B. Perform field inspection for pipe invert elevations.
- C. If inspections indicate work does not meet specified requirements, adjust work and reinspect at no cost to Owner.

END OF SECTION

SECTION 33 31 13
SITE SANITARY SEWERAGE GRAVITY PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Sanitary sewerage drainage piping, fittings, and accessories.

1.02 RELATED REQUIREMENTS

- A. Section 31 23 16.13 - Trenching: Excavating, bedding, and backfilling.

1.03 REFERENCE STANDARDS

- A. ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications; 2025.
- B. ASTM D3034 - Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings; 2024, with Editorial Revision (2025).

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

PART 2 PRODUCTS

2.01 SEWER PIPE MATERIALS

- A. Plastic Pipe: ASTM D3034, Type PSM, Poly(Vinyl Chloride) (PVC) material; inside nominal diameter of 8" inches (____ mm), bell and spigot style solvent sealed joint end.
- B. Fittings: Same material as pipe molded or formed to suit pipe size and end design, in required tee, bends, elbows, cleanouts, reducers, traps and other configurations required.

2.02 PIPE ACCESSORIES

- A. Trace Wire: Magnetic detectable conductor, clear plastic covering, imprinted with "Sewer Service" in large letters.

2.03 CLEANOUT MANHOLE

- A. Lid and Frame: Cast iron construction, hinged lid.
 - 1. Lid Design: _____.

PART 3 EXECUTION

3.01 TRENCHING

- A. See Section 31 23 16.13 for additional requirements.
- B. Backfill around sides and to top of pipe with cover fill, tamp in place and compact, then complete backfilling.

3.02 INSTALLATION - PIPE

- A. Install pipe, fittings, and accessories in accordance with manufacturer's instructions. Seal watertight.
 - 1. Plastic Pipe: Also comply with ASTM D2321.
- B. Lay pipe to slope gradients noted on layout drawings; with maximum variation from true slope of 1/8 inch (3 mm) in 10 feet (3 m).
- C. Install trace wire 6 inches (150 mm) above top of pipe; coordinate with Section 31 23 16.13.

3.03 INSTALLATION - CLEANOUTS

- A. Form bottom of excavation clean and smooth to correct elevation.
- B. Form and place cast-in-place concrete base pad, with provision for sanitary sewer pipe end sections.
- C. Establish elevations and pipe inverts for inlets and outlets as indicated.

- D. Mount lid and frame level in grout, secured to top cone section to elevation indicated.

3.04 FIELD QUALITY CONTROL

- A. Perform field inspection and testing in accordance with Section 01 40 00.

3.05 PROTECTION

- A. Protect pipe and bedding cover from damage or displacement until backfilling operation is in progress.

END OF SECTION

SECTION 33 42 11
STORMWATER GRAVITY PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Stormwater drainage piping.
- B. Stormwater pipe accessories.

1.02 RELATED REQUIREMENTS

- A. Section 31 23 16.13 - Trenching: Excavating, bedding, and backfilling.

1.03 REFERENCE STANDARDS

- A. ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications; 2025.
- B. ASTM D3034 - Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings; 2024, with Editorial Revision (2025).

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

PART 2 PRODUCTS

2.01 STORMWATER PIPE MATERIALS

- A. Provide products that comply with applicable code(s).
- B. Plastic Pipe: ASTM D3034, Type PSM, Poly Vinyl Chloride (PVC) material; inside nominal diameter of 6" inches (____ mm), bell and spigot style solvent sealed joint end.

2.02 PIPE ACCESSORIES

- A. Trace Wire: Magnetic detectable conductor, clear plastic covering, imprinted with "Stormwater Service" in large letters.

PART 3 EXECUTION

3.01 TRENCHING

- A. See Section 31 23 16.13 - Trenching for additional requirements.
- B. Backfill around sides and to top of pipe with cover fill, tamp in place and compact, then complete backfilling.

3.02 INSTALLATION

- A. Install pipe, fittings, and accessories in accordance with manufacturer's instructions. Seal watertight.
 - 1. Plastic Pipe: Also comply with ASTM D2321.
- B. Lay pipe to slope gradients noted on layout drawings; with maximum variation from true slope of 1/8 inch (3 mm) in 10 feet (3 m).
- C. Connect to building storm drainage system, foundation drainage system, and utility/municipal system.
- D. Install continuous trace wire 6 inches (150 mm) above top of pipe; coordinate with Section 31 23 16.13.

3.03 PROTECTION

- A. Protect pipe and bedding cover from damage or displacement until backfilling operation is in progress.

END OF SECTION

**SECTION 33 46 00
STORMWATER MANAGEMENT**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Dry Wells

1.02 REFERENCE STANDARDS

- A. City of Palmer Stand Specifications
- B. Alaska Department of Environmental Conservation (ADEC) – Alaska Storm Water Guide
- C. EPA Underground Injection Control (UIC) Program – Class V Stormwater Drainage Wells

1.03 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Manufacturer's data on each product to be used, including physical properties, seaming materials, and installation instructions.
- C. Shop Drawings: Indicate stack assembly, invert elevations, opening sizes, and pipe angles.
- D. Test Reports: Pre-construction infiltration test report

PART 2 PRODUCTS

2.01 DRY WELL

- A. Dry Well Structure
 - 1. Dry wells shall consist of precast concrete sections or engineered infiltration chambers designed for HS-20 loading where applicable.
- B. Aggregate
 - 1. Clean, washed gravel or crushed rock, 1.5 to 3 inches nominal size, with less than 2 percent fines.
- C. Geotextile
 - 1. Non-woven geotextile fabric with minimum grab tensile strength of 120 lbs.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 - 1. Verify excavations are at correct topographies and areas to be filled are not compromised with surface or ground water.

3.02 PREPARATION

- A. Coordinate placement of inlet and outlet pipe required by other sections.

3.03 DRY WELL

- A. Site Conditions
 - 1. Dry wells shall not be installed in frozen ground or where groundwater is encountered within the excavation.
- B. PRE-CONSTRUCTION INFILTRATION TESTING
 - 1. Prior to construction, the Contractor shall perform infiltration testing at the proposed dry well location under unfrozen soil conditions. Results shall be submitted to the Engineer for review and acceptance prior to proceeding with construction.
- C. EXCAVATION AND INSTALLATION
 - 1. Protect native soils from smearing, scarify sidewalls and bottom, install geotextile and aggregate, and construct dry well as shown on the Drawings.

D. BACKFILL AND RESTORATION

1. Restore surface features to original condition or as shown on the Drawings.

E. GROUNDWATER PROTECTION

1. Dry wells shall be constructed and operated in compliance with EPA Class V requirements to protect groundwater quality.

END OF SECTION