

SPECIFICATIONS

Hall Elementary School Portland Public Schools Portland, Maine

Volume 2 of 3

Prepared For:

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architecture
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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Cooking appliances.
- 2. Refrigeration appliances.
- 3. Cleaning appliances.

- B. Related Requirements:

- 1. Section 224100 "Residential Plumbing Fixtures" for kitchen sinks, dishwasher air-gap fittings, waste (garbage) disposers, and instant hot-water dispensers.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.

- B. Product Data: For each type of product.

- 1. Include installation details, material descriptions, dimensions of individual components, and finishes for each appliance.
- 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished accessories.

- C. Sustainable Design Submittals:

- 1. Product Data: For indicated products, indicating compliance with requirements for ENERGY STAR product labeling.
- 2. Product Data: For water-efficient clothes washer, indicating compliance with requirements.

- D. Samples: For each exposed product and for each color and texture specified, in manufacturer's standard size.
- E. Product Schedule: For appliances. Use same designations indicated on Drawings.

1.5 INFORMATIONAL SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Qualification Data: For manufacturer.
- C. Product Certificates: For each type of appliance.
- D. Field quality-control reports.
- E. Sample Warranties: For manufacturers' special warranties.

1.6 CLOSEOUT SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Operation and Maintenance Data: For each residential appliance to include in operation and maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Maintains, within 100 miles of Project site, a service center capable of providing parts, and emergency maintenance repairs.

1.8 WARRANTY

- A. Special Warranties: Manufacturer agrees to repair or replace residential appliances or components that fail in materials or workmanship within specified warranty period except as qualified below:
 - 1. Warranty Period: Five years from date of Substantial Completion.
- B. Electric Range: Limited warranty, including parts and labor for first year and parts thereafter, for on-site service on surface-burner elements.
 - 1. Warranty Period: Five years from date of Substantial Completion.
- C. Microwave Oven: Limited warranty, including parts and labor for first year and parts thereafter, for on-site service.

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1. Warranty Period: Five years from date of Substantial Completion.
- D. Refrigerator/Freezer, Sealed System: Limited warranty, including parts and labor for first year and parts thereafter, for on-site service on the product.
1. Warranty Period for Sealed Refrigeration System: Five years from date of Substantial Completion.
- E. Dishwasher: Limited warranty, including parts and labor for first year and parts thereafter, for on-site service on the product.
1. Warranty Period for Deterioration of Tub and Metal Door Liner: 10 years from date of Substantial Completion.
 2. Warranty Period for Other Components: Two years from date of Substantial Completion.
- F. Clothes Washer: Limited warranty, including parts and labor for first year and parts thereafter, for on-site service on the product.
1. Warranty Period: Three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain each type of residential appliance from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Electrical Appliances: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Accessibility: Where residential appliances are indicated to comply with accessibility requirements, comply with applicable provisions in the ABA standards of the Federal agency having jurisdiction.

2.3 RANGES

- A. Electric Range: Drop-in range with one oven and complying with AHAM ER-1.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Amana; a division of Whirlpool Corporation.
 - b. Electrolux Home Products (Frigidaire).
 - c. General Electric Company (GE Appliances).
 - d. General Electric Company (Hotpoint).
 - e. Jenn-Air; a division of Whirlpool Corporation.

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- f. [KitchenAid; a division of Whirlpool Corporation.](#)
 - g. [LG Electronics.](#)
 - h. [Maytag; a division of Whirlpool Corporation.](#)
 - i. [Samsung.](#)
 - j. [Sears Brands LLC \(Kenmore\).](#)
 - k. Whirlpool Corporation.
2. Width: 30 inches.
 3. Electric Burner Elements: Four.
 - a. Induction Type: Manufacturer's standard.
 - b. Controls: Digital panel controls, located on front.
 4. Oven Features:
 - a. Capacity: 4.4 cu. ft.
 - b. Operation: Baking and pyrolytic self-cleaning or catalytic continuous cleaning.
 - c. Broiler: Located in separate roll-out drawer on bottom.
 - d. Oven Door(s): Counterbalanced, removable, with observation window and full-width handle.
 - e. Electric Power Rating:
 - 1) Oven(s): Manufacturer's standard.
 - 2) Broiler: Manufacturer's standard.
 - f. Controls: Digital panel controls and timer display, located on front.
 5. Anti-Tip Device: Manufacturer's standard.
 6. Electric Power Supply: As indicated on Drawings.
 7. Material: Porcelain-enameled steel with manufacturer's standard ceramic-glass cooktop.
 - a. Color/Finish: White.

2.4 MICROWAVE OVENS

A. Microwave Oven:

1. [Manufacturers:](#) Subject to compliance with requirements, provide products by one of the following:
 - a. [Amana; a division of Whirlpool Corporation.](#)
 - b. [BSH Home Appliances Corporation \(Thermador\).](#)
 - c. [Electrolux Home Products \(Frigidaire\).](#)
 - d. [General Electric Company \(GE Appliances\).](#)
 - e. [General Electric Company \(Hotpoint\).](#)
 - f. [Jenn-Air; a division of Whirlpool Corporation.](#)
 - g. [KitchenAid; a division of Whirlpool Corporation.](#)
 - h. [LG Electronics.](#)
 - i. [Maytag; a division of Whirlpool Corporation.](#)

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- j. [Samsung](#).
 - k. [Sears Brands LLC \(Kenmore\)](#).
 - l. [Sub-Zero, Inc. \(Sub-Zero and Wolf\)](#).
 - m. Whirlpool Corporation.
2. Mounting: As indicated.
 3. Type: Conventional.
 4. Dimensions:
 - a. Width: 24 inches.
 - b. Depth: 19-1/2 inches.
 - c. Height: 14 inches.
 5. Capacity: 1.5 cu. ft.
 6. Oven Door: Door with observation window and pushbutton latch release.
 7. Exhaust Fan: Two-speed fan, nonvented, recirculating type with charcoal filter and with manufacturer's standard capacity.
 8. Microwave Power Rating: Manufacturer's standard.
 9. Electric Power Supply: As indicated on Drawings.
 10. Controls: Digital panel controls and timer display.
 11. Other Features: Turntable.
 12. Material: Manufacturer's standard.
 - a. Color/Finish: White.

2.5 REFRIGERATOR/FREEZERS

- A. Refrigerator/Freezer: Two-door refrigerator/freezer with freezer on top and complying with AHAM HRF-1.
 1. [Manufacturers](#): Subject to compliance with requirements, provide products by one of the following:
 - a. [Amana; a division of Whirlpool Corporation](#).
 - b. [BSH Home Appliances Corporation \(Thermador\)](#).
 - c. [Electrolux Home Products \(Frigidaire\)](#).
 - d. [General Electric Company \(GE Appliances\)](#).
 - e. [General Electric Company \(Hotpoint\)](#).
 - f. [Jenn-Air; a division of Whirlpool Corporation](#).
 - g. [KitchenAid; a division of Whirlpool Corporation](#).
 - h. [LG Electronics](#).
 - i. [Maytag; a division of Whirlpool Corporation](#).
 - j. [Samsung](#).
 - k. [Sears Brands LLC \(Kenmore\)](#).
 - l. [Sub-Zero, Inc. \(Sub-Zero and Wolf\)](#).
 - m. Whirlpool Corporation.
 2. Type: Freestanding.
 3. Dimensions:

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- a. Width: 30 inches.
 - b. Depth: 33-1/4 inches.
 - c. Height: 70 inches.
4. Storage Capacity:
- a. Refrigeration Compartment Volume: 15.6 cu. ft.
 - b. Freezer Volume: 5.13 cu. ft.
 - c. Shelf Area: Three adjustable wire shelves,
5. General Features:
- a. Door Configuration: Overlay.
 - b. Dual refrigeration systems.
 - c. Separate touch-pad temperature controls for each compartment.
6. Refrigerator Features:
- a. Interior light in refrigeration compartment.
 - b. Compartment Storage: vegetable crisper and meat compartment.
 - c. Door Storage: Modular compartments.
 - d. Temperature-controlled meat/deli bin.
7. Freezer Features: One freezer compartment(s) with door.
- a. Automatic defrost.
 - b. Interior light in freezer compartment.
8. ENERGY STAR: Provide appliances that qualify for the EPA/DOE ENERGY STAR product-labeling program.
9. Front Panel(s): Porcelain enamel.
- a. Panel Color: White.
10. Appliance Color/Finish: White.

2.6 DISHWASHERS

A. Dishwasher: Complying with AHAM DW-1.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Amana; a division of Whirlpool Corporation.
 - b. BSH Home Appliances Corporation (Thermador).
 - c. Electrolux Home Products (Frigidaire).
 - d. General Electric Company (GE Appliances).
 - e. General Electric Company (Hotpoint).
 - f. Jenn-Air; a division of Whirlpool Corporation.

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- g. [KitchenAid; a division of Whirlpool Corporation.](#)
 - h. [LG Electronics.](#)
 - i. [Maytag; a division of Whirlpool Corporation.](#)
 - j. [Samsung.](#)
 - k. [Sears Brands LLC \(Kenmore\).](#)
 - l. Whirlpool Corporation.
 2. Type: Built-in undercounter.
 3. Dimensions:
 - a. Width: 24 inches.
 - b. Depth: 25-3/4 inches.
 - c. Height: 34-1/2 inches.
 4. Capacity:
 - a. International Place Settings of China: 12.
 - b. Water Consumption for Full Load: 3.2 gal. per cycle.
 5. Sound Level: Maximum 48 dB.
 6. Tub and Door Liner: Manufacturer's standard with sealed detergent and automatic rinsing-aid dispensers.
 7. Rack System: PVC-coated sliding dish racks, with removable cutlery basket.
 8. Controls: Rotary-dial controls with four wash cycles and hot-air and heat-off drying cycle options.
 9. Features:
 - a. Waste food disposer.
 - b. Self-cleaning food-filter system.
 - c. Hot-water booster heater for 160 deg F wash water with incoming water at 100 deg F.
 - d. Lock-out feature.
 - e. Half-load option.
 - f. Delay-wash option.
 - g. Digital display panel.
 10. ENERGY STAR: Provide appliances that qualify for the EPA/DOE ENERGY STAR product-labeling program.
 11. Front Panel: Porcelain enamel.
 - a. Panel Color: White.
 12. Appliance Color/Finish: White.

2.7 CLOTHES WASHERS AND DRYERS

- A. Clothes Washer: Complying with AHAM HLW-1.

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1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. Amana; a division of Whirlpool Corporation.
 - b. Electrolux Home Products (Frigidaire).
 - c. General Electric Company (GE Appliances).
 - d. General Electric Company (Hotpoint).
 - e. LG Electronics.
 - f. Maytag; a division of Whirlpool Corporation.
 - g. Samsung.
 - h. Sears Brands LLC (Kenmore).
 - i. Whirlpool Corporation.
2. Type: Freestanding, top-loading unit.
3. Dimensions:
 - a. Width: 27 inches.
 - b. Depth: 29 inches.
 - c. Height: 38 inches.
4. Drum: Manufacturer's standard.
 - a. Capacity: 3.2 cu. ft.
5. Controls: Touch-pad controls for water-fill levels, wash/rinse water temperatures, and variable-speed and fabric selectors.
 - a. Wash Cycles: Six wash cycles, including regular, delicate, and permanent press.
 - b. Wash Temperatures: Three settings.
 - c. Speed Combinations: Five.
6. Electrical Power: As indicated on Drawings.
7. Motor: Manufacturer's standard with built-in overload protector.
8. Features:
 - a. Agitator: Impeller (without spindle).
 - b. Self-cleaning lint filter.
 - c. Unbalanced-load compensator.
 - d. Inlet Hoses: Minimum length 60 inches.
 - e. Drain Hoses: Minimum length 48 inches.
 - f. Self-leveling legs.
 - g. Automatic dispenser for bleach, fabric softener and detergent.
 - h. Spin-cycle safety switch.
 - i. End-of-cycle signal.
 - j. Extra-rinse option.
 - k. Delay-wash option.
 - l. Electronic temperature control.
 - m. Water levels automatically set.

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9. ENERGY STAR: Provide appliances that qualify for the EPA/DOE ENERGY STAR product-labeling program.
 10. Water-Efficient Clothes Washer: Provide clothes washer with modified energy factor greater than or equal to 2.0 and water factor less than 5.5.
 11. Appliance Finish: Enamel.
 - a. Color: White.
- B. Clothes Dryer: Complying with AHAM HLD-1.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Amana; a division of Whirlpool Corporation.
 - b. Electrolux Home Products (Frigidaire).
 - c. General Electric Company (GE Appliances).
 - d. General Electric Company (Hotpoint).
 - e. LG Electronics.
 - f. Maytag; a division of Whirlpool Corporation.
 - g. Samsung.
 - h. Sears Brands LLC (Kenmore).
 - i. Whirlpool Corporation.
 2. Type: Freestanding, frontloading, electric unit.
 3. Dimensions:
 - a. Width: 27 inches.
 - b. Depth: 31 inches.
 - c. Height: 36 inches.
 4. Drum: Manufacturer's standard.
 - a. Capacity: 7.0 cu. ft.
 5. Controls: Touch-pad controls for drying cycle, temperatures, and fabric selectors.
 6. Electric-Dryer Power: As indicated on Drawings.
 7. Features:
 - a. Removable lint filter.
 - b. Electronic temperature and moisture-level-sensor controls.
 - c. End-of-cycle signal.
 - d. Interior drum light.
 - e. Self-leveling legs.
 - f. Antibacterial cycle.
 - g. Auxiliary drying rack.
 - h. Built-in electrical power fuse.
 8. Appliance Finish: Enamel.
 - a. Color: White.

2.8 CLOTHES WASHER/DRYER COMBINATIONS

A. Clothes Washer/Dryer Combination: Complying with AHAM HLW-1.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Electrolux Home Products (Frigidaire).
 - b. LG Electronics.
 - c. Maytag; a division of Whirlpool Corporation.
 - d. Sears Brands LLC (Kenmore).
 - e. Whirlpool Corporation.
2. Type: Freestanding washer/dryer unit with dual-drum design and electric dryer; washer is top loading.
3. Dimensions:
 - a. Width: 27 inches.
 - b. Depth: 32 inches.
 - c. Height: 71-1/2 inches.
4. Washer and Dryer Drums: Manufacturer's standard.
 - a. Washer-Drum Capacity: 2.0 cu. ft.
 - b. Dryer-Drum Capacity: 2.0 cu. ft.
5. Washer Controls: Touch-pad controls for water-fill levels, wash/rinse water temperatures, and variable-speed and fabric selectors.
6. Dryer Controls: Touch-pad controls for drying cycle, temperatures, and fabric selectors.
 - a. Wash Cycles: Three wash cycles, including regular, delicate, and permanent press.
 - b. Wash Temperatures: Three settings.
 - c. Speed Combinations: Two.
7. Electric Washer/Dryer Power: As indicated on Drawings.
8. Motor: Manufacturer's standard with built-in overload protector.
9. Washing Features:
 - a. Self-cleaning lint filter.
 - b. Unbalanced-load compensator.
 - c. Inlet Hoses: Minimum length 60 inches.
 - d. Drain Hoses: Minimum length 48 inches.
 - e. Self-leveling legs.
 - f. Automatic dispenser for bleach, fabric softener and detergent.
 - g. Spin-cycle safety switch.
10. Drying Features:
 - a. Removable lint filter.
 - b. Electronic temperature and moisture-level-sensor controls.

- c. End-of-cycle signal.
 - d. Interior drum light.
- 11. ENERGY STAR: Provide appliances that qualify for the EPA/DOE ENERGY STAR product-labeling program.
 - 12. Water-Efficient Clothes Washer: Provide clothes washer with modified energy factor greater than or equal to 2.0 and water factor less than 5.5.
 - 13. Appliance Finish: Enamel.
 - a. Color: White.

2.9 GENERAL FINISH REQUIREMENTS

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, power connections, and other conditions affecting installation and performance of residential appliances.
- B. Examine roughing-in for piping systems to verify actual locations of piping connections before appliance installation.
- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install appliances according to manufacturer's written instructions.
- B. Built-in Equipment: Securely anchor units to supporting cabinets or countertops with concealed fasteners. Verify that clearances are adequate for proper functioning and that rough openings are completely concealed.
- C. Freestanding Equipment: Place units in final locations after finishes have been completed in each area. Verify that clearances are adequate to properly operate equipment.

- D. Range Anti-Tip Device: Install at each range according to manufacturer's written instructions.

3.3 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Perform visual, mechanical, and electrical inspection and testing for each appliance according to manufacturers' written recommendations. Certify compliance with each manufacturer's appliance-performance parameters.
 - 2. Leak Test: After installation, test for leaks. Repair leaks and retest until no leaks exist.
 - 3. Operational Test: After installation, start units to confirm proper operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and components.
- B. An appliance will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain residential appliances.

END OF SECTION

SECTION 11 40 00 - FOODSERVICE EQUIPMENT

PART 1 - GENERAL

1 RELATED DOCUMENTS

- A The general conditions of division 1 including supplementary conditions and general requirements apply to the work specified in this section.

2 RELATED WORK, NOT INCLUDED BY FOODSERVICE EQUIPMENT CONTRACTOR

- A Plumbing: Refer to division 22 00 00 including
- 1 Rough-in
 - 2 Piping for supply and waste lines.
 - 3 Traps, grease traps, line strainers, tail pieces, valves, stops, shutoffs, and miscellaneous fittings required for complete installation.
 - 4 Final connection, including mounting of foodservice equipment contractor supplied faucets and waste assemblies.
- B Ventilation: Refer to division 23 00 00 including
- 1 Final utility connections.
 - 2 Exhaust Hoods and Fans to be received and installed by HVAC contractor.
- C Electrical: Refer to division 26 00 00 including
- 1 Rough-in.
 - 2 Conduit, wiring, line and disconnect switches, safety cutoffs and fittings, control panels, fuses, boxes and fittings required for complete installation.
 - 3 Final connections, including mounting and wiring of starters and switches furnished as part of the foodservice equipment (unless otherwise indicated on the drawing).

3 WORK INCLUDED IN THIS SECTION

- A Furnish point of connections and install all foodservice equipment here-in, including that which is reasonably inferred, with all related items necessary to complete work shown on contract drawings and/or required by these specifications.
- B Electrical Work:
- 1 Interwiring of foodservice equipment between components within equipment, such as heating elements, switches, thermostats, motors, etc., complete with junction box or disconnect switch as is applicable, ready for final connection.
 - 2 Voltages shall be as indicated on contract drawings. Any difference in electrical characteristics at job site from those shown on contract documents must be submitted to the architect for consideration prior to ordering equipment.

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C Plumbing Work:

- 1 Furnish all equipment with faucets and sink waste assemblies as specified in this section. All plumbing fixtures to be in compliance with S.3874 (The Reduction of Lead in Drinking Water Act)

4 SUBMITTALS

- A Submit shop drawings as required by general conditions.
- B Shop drawings and bound brochures covering manufactured or "buy-out" items covering all work and equipment included in this contract shall be submitted to owner as soon as possible after award of contract. After approval, foodservice contractor shall furnish to architect sets of shop drawings and brochures, corrected as required by virtue of review comments, for distribution to various interested trades on project. All cost of reproduction shall be part of contract.
- C Provide fully dimensioned rough-in plans at 1/4" scale, showing all required mechanical, electrical, ventilation, water waste, and refrigeration services for equipment and rough-in locations for same. Rough-in locations shown shall make allowances for traps, switches, etc., thereby not requiring interpretation or adjustment on the part of other contractors. Drawings shall indicate dimensions for floor depressions, wall openings, etc., for equipment.
- D Foodservice equipment contractor shall visit site to verify all rough-in and sleeve locations prior to installation of finished floors, and shall cooperate with other contractors involved in proper location of same.
- E Fully dimensioned and detailed shop drawings of custom-fabricated equipment items shall be submitted, drawn at 3/4" and 1/2" scale for plans, elevations, and sections, respectively. Drawings shall show all details of construction, installation, and relation to adjoining and related work where cutting or close fitting is required. Drawings shall show all reinforcements, anchorage, and other work required for complete installation of all fixtures.
- F Do not begin fabrication of custom-manufactured equipment until approvals of shop drawings have been received, and until field measurements have been taken by foodservice equipment contractor, where such measurements are necessary to assure proper conformance with intent of contract drawings and specifications.
- G Make field measurements, giving due consideration to any architectural, mechanical, or structural discrepancies that may occur during construction of building. No extra compensation will be allowed for any difference between actual measurements secured at job site and dimensions shown on drawings. Field measurements shall be submitted to architect for consideration before proceeding with fabrication of equipment.
- H Submit illustrated brochures for manufactured or "buy-out" equipment items complete with illustrations, specifications, line drawings, rough-in requirements, and list of accessories or other specified additional requirements. Brochures shall be bound and shall include data on all equipment that is to be provided, arranged in numerical sequence that conforms to item numbers of specifications. Omission of data does not reduce obligation to provide items as specified.

5 SUBSTITUTIONS – STANDARDS

- A Proposals shall be based on brands, materials, and forms of construction specified unless products of other manufacturers that conform to requirements of plan and specifications are approved in writing by owner as equal to that as specified.
- B Any equipment offered for approval as "equal" to equipment specified must conform to space limitations of layout. Cost of any deviation from kind or location of mechanical service provided in layout due to furnishing of an approved equal will be the responsibility of foodservice contractor, at no extra cost to owner.
- C If no equals are approved in writing by owner, the brands and materials specified must be furnished, and no other substitution will be permitted subsequent to award of contract except by specific change order issued by owner.

6 DRAWINGS

- A Drawings that constitute part of contract documents indicate general arrangement of piping and location of equipment. Should it be necessary to deviate from arrangement indicated in order to meet structural conditions, make such deviations without expense to owner.
- B Specifications and drawings are reasonably exact, but their extreme accuracy is not guaranteed. Drawings and specifications are for assistance and guidance of contractor, and exact locations, distances, and levels shall be governed by the building.

7 MANUFACTURER'S DIRECTIONS

- A Follow manufacturer's directions in all cases where manufacturers of articles used in this contract furnish directions or prints covering points not shown on drawings or specifications.

8 QUALITY ASSURANCE

- A It is required that all custom-fabricated equipment such as tables, sinks, countertops, etc., be manufactured by a foodservice equipment fabricator who has a plant, personnel and engineering required. Such manufacturer shall be subject to approval of architect. All work in the above category shall be manufactured by one manufacturer, and shall be of uniform design and finish.
- B Manufacturer of this equipment must be able to show that he is now and for the past five years has been engaged in manufacture or distribution of equipment, as required under this contract.
- C Manufacturer of this equipment herein specified shall be a recognized distributor for items of equipment specified herein that are of other manufacture than his own.
- D Only manufacturers who can meet the foregoing qualifications will be acceptable.

9 INDUSTRY STANDARDS

- A Electrically operated and/or heated equipment, fabricated or otherwise, shall conform to latest standards of National Electric Manufacturers Association and of Underwriters Laboratories, Inc., and shall bear the U.L. label.
- B Items of foodservice equipment furnished shall conform to standards of National Sanitation Foundation, Ann Arbor, Michigan, and shall bear the N.S.F seal.
- C Foodservice equipment shall be installed in accordance with N.S.F. standards.
- D Work and material shall be in compliance with requirements of applicable codes, ordinances, and regulations, including but not limited to those of the National Fire Protection Association, State Fire Marshal, State Board of Health, Local Health Codes, etc.
- E Rulings and interpretations of enforcing agencies shall be considered part of regulations.

10 EQUIPMENT HANDLING AND STORAGE

- A Deliver equipment to site, properly crated and protected, and store in safe place. Protect from damage until time for installation.

11 GUARANTEE

- A Equipment furnished under this contract shall be guaranteed for a period of one year from the date of final acceptance thereof against defective materials, designs, and workmanship. Upon receipt of notice of failure, any part or parts shall be replaced promptly, at the expense of foodservice equipment contractor. Until replacement equipment is installed, owner shall have full use of defective equipment. Warranty shall include labor, all parts, and driving time to and from job site.
- B This guarantee shall include installation, start-up, and one-year free service for all self-contained refrigeration equipment furnished under this contract, with evidence of manufacturer's one-year guarantee on entire cabinet, and additional four-year warranty on sealed compressor motor assembly.

12 OPERATING AND MAINTENANCE MANUALS

- A After completion of installation, foodservice equipment contractor shall present to owner three sets of all operating and maintenance manuals, covering all mechanically operated equipment furnished under this contract, each set being bound in loose leaf binder having durable cover. Include in each binder a list of names, addresses, and telephone numbers of service agencies authorized to make necessary repairs and/or adjustments of equipment furnished under this contract.

PART 2 - PRODUCTS

1 MANUFACTURED EQUIPMENT

- A Except as may be specified otherwise under individual item specifications in "Equipment Schedule," all items of standard manufactured equipment furnished shall be complete in accord with manufacturer's standard specifications for specific unit or model called for, including finishes, components, attachments, appurtenances, etc., except as follows:
- B Substitutions for manufactured equipment specified will be accorded consideration under terms set forth in "Substitutions-Standards."

2 FABRICATED EQUIPMENT

- A Work shall be done in an approved workmanlike manner, to complete satisfaction of owner.
- B Stainless steel shall be U.S. standard gauges as called for, 18-8, Type 304, not over .012% maximum carbon, No. 4 finish.
- C Galvanized iron shall be Armco or equal. Framework of galvanized iron shall be welded construction, having welds smooth, and where galvanizing has been burned off, touched up with high-grade aluminum bronze.
- D Legs and crossrails shall be continuously welded, unless otherwise noted, and ground smooth.
- E Bottom of legs at floor shall be fitted with sanitary stainless steel bullet-type foot, with no less than 1-1/2" adjustment.
- F Legs shall be fastened to equipment as follows:
 - 1 To sinks by means of closed gussets. Gussets shall be stainless steel, reinforced with bushings, having set screws for securing legs.
 - 2 To tables and drainboards with closed gussets which shall be welded to galvanized (when not exposed) or S/S (when exposed) hat channels, 14 gauge or heavier, exposed hat sections having closed ends. Bracing shall be underside of tops.
- G Closed gussets shall be 3" minimum diameter at top, welded to frame members or to sink bottom.
- H Sinks, unless otherwise specified, shall be furnished with lever-type waste outlets with connected overflows. Where exposed, furnish wastes chromium plated.
- I Rolls shall be 1 1/2" diameter, except as detailed to the contrary, with corners bullnosed, ground, and polished.
- J Seams and joints shall be shop-welded. Welds to be ground and polished to match original finish. Materials 18 gauge or heavier shall be welded.

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- K Metal tops shall be one-piece welded construction, unless specified otherwise, reinforced on underside with galvanized hat channels welded in place. Crossbracing not to be more than 30" on center.
- L Drawers to be 18 gauge stainless steel channel-type housing and drawer cradle, both cradle and housing being reinforced and welded at corners, housing being secured to underside of tabletop, and both housing and cradle being sized for and fitted with 20" x 20" x 5" deep thermo plastic drawer insert having coved corners. Drawer insert shall be easily removable from cradle without tools or having to remove entire drawer.
- M Drawer fronts and doors: Except where single-pan construction is indicated, provide double-pan type, not less than 5/8" thick, with seams on inside face. Deadened sound by inserting mineral wool insulation between pans.
- N Hardware shall be solid materials and except where unexposed or specified to the contrary, of cast brass, chrome-plated. Identify all hardware with manufacturer's name and number so that broken or worn parts may be ordered and replaced.
- O Fabricate sink compartments with 3/4" coved vertical and horizontal corners. Multiple-compartment partitions to be double thickness, continuously welded where sheets join at top. Front of multiple-compartment sinks to be continuous on exterior. Bottoms to be creased to drain.
- P Ends of fixtures, splashbacks, shelves, etc., shall be finished flush to walls or adjoining fixtures.
- Q Dishtables, drainboards, splashbacks, and turn-up edges shall have radius bends in all horizontal and vertical corners, coved at intersections.
- R Rounded and coved corners or radius bends shall be 1/2" radius or longer.
- S Undersides of tops to be coated with sound deadening tacky tape. Sinks are to be coated with Component Hardware sound deadening compound.
- T Shelves are to be turned up 2" on back edge. Turn other edges down 1 1/2" to form open channels. Reinforce shelf units to support 40 lbs. per square foot loading, plus 100% impact loading.
- U Casework at fabricator's option, unless otherwise indicated. Provide either box-type framing or open-channel-type (complying with N.S.F. requirements in either case).
- V Enclosures: Except as indicated, provide each unit of casework (base, wall overhead, and free-standing) with a complete-enclosure metal cabinet, including fronts, backs, tops, bottoms, and sides.
- W Metal components, unless specified or noted otherwise, to be the following gauges:

1	Tabletops	14 gauge	Stainless steel
2	Wall shelves	16 gauge	"
3	Undershelves	16 gauge	"
4	Drawer fronts (single pan)	16 gauge	"
5	Enclosed cabinet bases	18 gauge	"

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6	Sinks and drainboards	14 gauge	"
7	Exhaust hoods	18 gauge	"
8	Legs (1-5/8" dia.)	16 gauge	"
9	Cross bracing (1" dia.)	16 gauge	"
10	Doors (outer pan)	18 gauge	"
11	Doors (inner pan)	20 gauge	"

3 HEATING EQUIPMENT

- A Wherever heating equipment or thermostat control for such equipment is specified, it shall be complete, and of the materials, size, and rating specified within equipment items or details. All such equipment shall be designed and installed to be easily cleaned or to be easily removed for cleaning.
- B Electrical appliances or heating element circuits of 120 volts shall not exceed 1650 watts, unless specifically shown to the contrary.

4 SWITCHES AND CONTROLS

- A All internal wiring for fabricated equipment items, including all electrical devices, wiring, controls, switches, etc., built into or forming an integral part of these items shall be furnished and installed by foodservice equipment contractor in his factory or building site with all items complete to junction box for final connection to building lines by electrical contractor.
- B Provide standard 3-prong plugs to fit "U" slot grounding-type receptacles, for all equipment items powered by plugging into 110-120 volts, single-phase AC.

5 CONNECTION TERMINALS

- A All equipment shall be complete with connection terminals as standardized by equipment manufacture, except where specified otherwise.

6 LOCKS

- A Fit all doors for reach-in refrigerated compartments with locking-type latches.

7 LAMINATE PLASTICS

- A Wherever laminate plastic materials are specified, veneer all materials using urea base cement, waterproof, and heatproof. Rubber base adhesives are not acceptable. Apply materials directly over close-grained plywood face exposed surfaces and edges with 1/16" material, and corresponding back faces with 1/32" reject material. Place top sheet on and over finished edge.

PART 3 - EXECUTION

1 EXECUTION

- A Work under this contract and covered under this section of specification includes but not limited to:
- 1 Cutting of holes and/or ferrules on equipment for piping, drains, electrical outlets, conduits, etc., as required to coordinate installation of kitchen and foodservice equipment work of the other contractors on project.
 - 2 Field checking of building and rough-in requirements, and submission of brochures and shop drawings, all as required herein before under "submittals."
 - 3 Repair of all damage to premises as result of this installation, and removal of all debris left by those engaged in this installation.
 - 4 Having all foodservice equipment fixtures completely cleaned and ready for operation when building is turned over to owner.

2 INSTALLATION PROCEDURES

- A Foodservice equipment contractor shall make arrangements for receiving his custom-fabricated and "buy-out" equipment and shall make delivery into building as requisitioned by his installation superintendent. He shall not consign any of his equipment to owner or to any other contractor unless he has written acceptance from them and has made satisfactory arrangements for the payment of all freight and handling charges.
- B Foodservice equipment contractor shall deliver all of his custom-fabricated and "buy-out" equipment temporarily in its final location, permitting trades to make necessary arrangements for connection of service lines.
- C This contractor shall coordinate his work and cooperate with other trades working at site toward the orderly progress of the project.
- D Owner or owner's agent shall have access at all times to plant or shop in which custom-fabricated equipment is being manufactured, from time contract is let until equipment is shipped, in order that progress of work can be checked, as well as any technical problems that may arise in coordination of equipment with building. Any approval given at this point of manufacturer shall be tentative, subject to final inspection and test after complete installation.
- E Foodservice equipment contractor shall assist owner, and/or owner's agent, in making any desired tests during or prior to final inspection of equipment; he shall remove immediately any work or equipment rejected by owner, and/or owner's agent, replacing the same with work conforming to contract requirements.
- F This contractor shall keep premises free from accumulation of his waste material and rubbish, and at completion of his work shall remove his rubbish and implements, leaving areas of his workroom clean.

- G This contractor shall provide and maintain coverings or other protection for finished surfaces and other parts of his equipment subject to damage during and after erection. After removal of protective coverings, all field joints shall be ground and polished, and entire work shall be thoroughly cleaned and polished.

3 TRIMMING AND SEALING EQUIPMENT

- A Seal completely spaces between all units to walls, ceilings, floors, and adjoining (not portable) units with enclosed bodies against entrances of food particles or vermin by means of trim strips, welding, soldering, or commercial joint material best suited to nature of equipment and adjoining surface material.
- B Close ends of all hollow sections.
- C Equipment butting against walls, ceilings, floor surfaces, and corners to fit tightly against same; backsplashes or risers that fit against wall to be neatly scribed and sealed with a N.S.F. approved clear silicone sealant, wiping excess out of joint to fillet radius. Where required to prevent shifting of equipment and breaking wall seal, anchor item to floor or wall.

4 TESTING AND DEMONSTRATION OF EQUIPMENT

- A After complete installation, all items of equipment furnished under this contract shall be thoroughly tested to ensure proper and safe operation.
- B Foodservice equipment contractor shall arrange to have all manufactured, mechanically operated equipment furnished under this contract demonstrated by manufacturer's representatives. These representatives to instruct owner's designated personnel in use, care, and maintenance of all items of equipment after same are in working order. Demonstration and instruction shall be held on dates designated by owner.
- C Foodservice equipment contractor shall provide a competent service representative to be present when installation is put into operation.

5 ITEMIZED SPECIFICATIONS

Item #: 1
Description: Mop Sink
Manufacturer: Advance/Tabco
Model #: 9-OP-20
SIS #: T037
Quantity: 1
Alternate Manufacturer: Eagle, IMC Teddy,

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Specification:

Unit to be model 9-OP-20 Mop Sink as manufactured by Advance/Tabco and with the following features: Floor mounted unit eliminates the need of lifting heavy containers. No-Drip die formed recessed V-edge on three sides with a tile edge furnished on the rear. Sink bowl is seamless and DEEP DRAWN designed. DEEP DRAWN bowls having large liberal radii with a minimum dimension of 3" and rectangular in design for increased capacity.

Construction: All TIG welded. Welded areas blended to match adjacent surfaces and to a satin finish.

Mechanical: Supply is 1/2" hot and cold. Drain is cast brass with 2" IPS male threads. Stainless steel drain body is designed for a lead caulk joint to a 2" drain pipe.

Material: Entire unit is 16-gauge type 304 series stainless steel.

Unit to be complete with the following options and accessories:

- (1) One model # K-240 service faucet.
- (1) One model # K-242 mop hanger.
- (1) One model # K-244 hose and hanger.
- (1) One model # K-288L 16" high left side and back splashes.

Item #: 2

Description: Shelving Unit

Manufacturer: Cambro

Model #: ESU214872V4

SIS #: T037

Quantity: 1

Alternate Manufacturer: Metro

Specification:

Unit to be a 4-Shelf Cambro Elements Series Starter Stationary Unit with the following features: Shelf Plates only with Camguard antimicrobial. 3 Post Heights 64", 72", 84". 3 Shelf Widths 18", 21", 24". 5 Shelf Lengths 36", 42", 48", 54", 60".

Each Starter Unit shall include: 4 stationary posts with leveling feet installed pre-assembled with post connectors and wedges, 1 bag of 32 stationary traverse dovetails (16 ea. A and B), Vented shelf plates (for 4 shelves), 8 stationary traverses and instructions.

Posts: Proprietary non-corrosive composite material. Post Connectors: Glass Filled Polypropylene. Traverses: Proprietary non-corrosive composite material. Vented/Solid Shelf Plates: Reinforced polypropylene with Camguard antimicrobial. Corner Connectors: Glass Filled Polypropylene. Adjustable Foot: Glass Filled Nylon. Seismic Foot: Stainless Steel post and wide foot plate, 3 holes for bolts. (Bolts not provided) Divider Bars: Glass Filled Nylon. Wall Fastener: Stainless Steel. Dovetails: Resin Nylon Wedges: Resin Polypropylene

- (1) One unit at 21" x 48" x 72" high. (model # ESU214872V4)

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Item #: 3

Description: Dishtable, Clean

Manufacturer: Fabricated

Model #: Custom

SIS #: T037

Quantity: 1

Specification:

Unit to be size and shape as per plan and details. 6'-6" long. Unit to feature 14-gauge stainless steel, type 304 18/8, and polished to a #4 satin finish. All seams to be welded, ground smooth and polished. All horizontal and vertical bends to be rounded to a 3/4" radius with all intersections to have coved corners. Unit to be 2'-6" wide x 2'-10" high with 3" rolled rim on front and right edge. Backsplash shall be 10" high with 2" return to wall at 45° with ends closed. Table to include a minimum of four stainless steel leg assemblies with stainless steel feet and undershelf notched and welded to legs.

Item #: 4

Description: Condensate Hood

Manufacturer: Captive-Aire

Model #: 4224VHB-G

SIS #: T037

Quantity: 1

Specification:

Unit to be model 4224VHB-G 6'-0" long condensate hood with full perimeter gutter as manufactured by Captive-Aire and with the following features:

Condensate hood is a single vent hood used for non-grease applications for the removal of heat, vapor, etc. Hood shall have the size, shape and performance as specified on the drawings.

Finish shall be #3 or #4 polish where exposed. Hood shall be wall or island type with fully welded 10-gauge corner hanging angles. Corner hanging angles have a .625 x 1.500 slot pre-punched at the factory; this allows hanging rods to be used for quick and safe installations. Hanging rod and connection is provided by and installed by others.

The hood manufacture shall supply complete submittal drawings including hood section views(s) and hood plan view(s). These drawings must be made available to the engineer, architect and owner for their use in construction, operation and maintenance.

Exhaust duct collar to be 4" high with 1" flanges. Duct sizes, CFM and static pressure requirements shall be as shown on the drawings.

Unit to be complete with the following options and accessories:

- 430 Stainless Steel – 100% Application.
- Exhaust Riser – Factory installed 10" diameter x 4" height.
- Field Wrapper – 6" high front, left and right.

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Item #: 5

Description: Dishwasher, Door-Type with Booster Heater

Manufacturer: Hobart

Model #: AM15

SIS #: T037

Quantity: 1

Alternate Manufacturer: Champion, Jackson, Meiko

Specification:

Unit to be model AM15 Dishwasher as manufactured by Hobart and with the following features:

The microcomputer-based control system is built into the AM Select dishwasher. It is available in standard electrical specifications of 208-240/60/1, 208-240/60/3, 480/60/3, 200-240/50/3, 380-415/50/3 and is equipped with a reduced voltage pilot circuit transformer.

Construction: Drawn tank, tank shelf and feet constructed of 16-gauge stainless steel. Wash chamber and front trim panel above motor compartment are polished, satin finish. Frame is 12-gauge stainless steel, chamber is 18 gauge, and removable trim panels are 20 gauge.

Chamber Lift: Chamber coupled by stainless steel handle, spring counterbalanced. Chamber guided for ease of operation and long life.

Pump: With stainless steel pump and impeller, integral with motor assures alignment and quiet operation. Pump shaft seal with stainless steel parts and a carbon ceramic sealing interface. Easily removable impeller housing permits ease of inspection. Capacity 160 GPM. Pump is completely self-draining.

Motor: Built for Hobart, 2 H.P., with inherent thermal protection, grease-packed ball bearings, splash-proof design, ventilated. Single-phase is capacitor-start, induction-run type. Three-phase is squirrel-cage, induction type.

Microcomputer Control System: Hobart microcomputer controls, assembled within water-resistant enclosure, provide built-in performance and reliability.

The microcomputer control, relays and contactors are housed behind a stainless steel enclosure, hinged to provide easy access for servicing. The line voltage electrical components are completely wired with 105°C, 600V thermoplastic insulated wire with stranded conductors and routed through listed electrical conduit. Electrical components are wired with type ST cord. Line disconnect switch NOT furnished.

Cycle Operation: The microcomputer-timing program is started by closing the doors, which actuates the door cycle switch. The microcomputer energizes the wash pump motor contactor during the wash portion of the program. After the wash, a dwell permits the upper wash manifold to drain. At the end of the dwell, the final rinse solenoid valve is energized. After the final rinse valve closes, Sani-Dwell (Hot Water Mode only) permits sanitization to continue. The Rinse display remains on during this period, completing the program. If the microcomputer is interrupted during a cycle by the door-cycle switch, the microcomputer is reset to the beginning of the program. Hot Water Sanitizing (58 racks per hour) – 57 seconds: 38 Second Wash, 2 Second Dwell, 10 Second Rinse, 7 Second Sani-Dwell. Other programs can be pre-selected by your Hobart service technician.

Manual wash cycle selector also provides selection of 2-, 4- or 6-minute wash cycles for heavier washing applications.

Wash: Hobart revolving stainless steel wash arms with unrestricted openings above and below provide thorough distribution of water jets to all dishware surfaces. Arms are easily removable for cleaning and are interchangeable. Stainless steel tubing manifold connects upper and lower spray system.

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Rinse: Rotating rinse arms, both upper and lower, feature 14 rinse nozzles. The stainless steel upper and lower rinse arms are easily removable without tools for inspection and are interchangeable. Diaphragm-type rinse control solenoid valve mounted outside machine. Machine is equipped with special hot water vacuum breaker on downstream side of rinse valve – mounted 6" above uppermost rinse opening. Easy open brass line strainer furnished.

Fill: Microcomputer controlled fill valve installed on upstream side of rinse vacuum breaker. Ratio fill method is used giving the correct fill at any flowing water pressure. (20 PSIG minimum necessary for proper rinsing.)

Drain and Overflow: Large bell type automatic overflow and drain valve controlled from inside of machine. Drain automatically closed by lowering chamber. Drain seal is large diameter, high temperature "O" ring. Cover for overflow is integral part of the standpipe.

Strainer System: Equipped with large, exclusive self-flushing, easily removable perforated stainless steel, one-piece strainer and large capacity scrap basket. Submerged scrap basket minimizes frequent removal and cleaning.

Heating Equipment: Standard tank heat is 5KW electric immersion heating element. Regulated power infrared gas immersion tube system is optional at extra cost. A solid-state igniter board controls the gas valve and provides flame ignition. A transformer steps the control circuit voltage down to 24 volts to power the igniter board and gas valves.

Unit to be complete with the following options and accessories:

- Voltage: 208-240/60/3, 45.4-Amps.
- Sense-A-Temp 70°F rise electric booster heater.
- Single point electrical connection for booster equipped machines.
- (1) One ¾" pressure regulator valve.
- (2) Two peg racks.
- (2) Two combination racks.
- (1) Drain water tempering kit.

Item #: 6

Description: Dishtable, Soiled

Manufacturer: Fabricated

Model #: Custom

SIS #: T037

Quantity: 2

Specification:

Unit to be size and shape as shown on plan and in detail. "L" shaped. Unit to feature 14-gauge stainless steel, type 304 18/8, and polished to a #4 satin finish. All seams to be welded, ground smooth and polished. All horizontal and vertical bends to be rounded to a ¾" radius with all intersections to have coved corners. 2'-6" wide x 2'-10" high with 3" rolled rim on front and left edge. Top shall extend 1" through pass opening with inverted "V" edge. Edge to be turned down 2" and returned to wall with ends closed. Carry 10" high flat backsplash to wall behind tracks of rolling service door. Extend 10" high side splash through opening. Balance of 10" high splash to have 2" return at 45° with ends closed. Top to be complete with one 20" x 20" x 6" deep pre-rinse sink with removable stainless steel rack slides. Included with this unit shall be a T&S Brass model B-0133 pre-rinse spray and B-109-1 wall bracket. Table to include a minimum of six stainless steel leg assemblies with stainless steel feet and stainless steel undershelf notched and

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welded to legs. Make provisions for disposer control panel, disposer collar, and holes for vacuum breaker in backsplash.

Unit shall be complete with one stainless steel window frame. Sized and shape as shown on plan and in detail. Constructed of 16-gauge type 304 stainless steel and polished to a #4 satin finish. Unit to be telescoping (split) type frame construction with 2" flush return on kitchen side and 2" return at 90 degrees with ½" return to wall on cafeteria side with all ends closed.

Item #: 7

Description: Disposer

Manufacturer: Insinkerator

Model #: SS-200-7-CC101

SIS #: T037

Quantity: 1

Alternate Manufacturer: Salvajor

Specification:

Product Overview:

- Corrosion resistant stainless steel grind chamber.
- 3/4" (19.1 mm) rubber mounting above grinding chamber, enclosed in chrome plated covers for sanitation and appearance.
- 2 H.P. induction motor with built-in thermal overload protection, 1725 RPM, totally enclosed to provide protection against outside moisture with controlled power air flow to cool motor—provides better efficiency, longer life.
- Cast nickel chrome alloy stationary and rotating shredding elements for long life and corrosion resistance, designed for reverse action grinding.
- Double-tapered Timken roller bearings provide a shock absorbing cushion.
- Triple lip seal protects motor from water damage and secondary spring-loaded oil seal provides double protection against water and loss of grease.
- Stainless steel and chrome plated finish—paint-free for lasting sanitation.

Unit to be complete with:

- Base disposer: model SS-200
- Mounting Gasket.
- Support Legs.
- Mounting Assembly: #7 Collar Adaptor for welding into sink.
- Electrical Control: CC-101 Auto-Reversing Control Center.
- Syphon breaker: model 13412, (chrome, 45° fittings)
- Solenoid Valve.
- Flow Control Valve.
- Voltage: 208-Volt, 3-Phase, 2-HP, 3.3-Amps

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Item #: 8

Description: Sink, 3-Compartment

Manufacturer: Fabricated

Model #: Custom

SIS #: T037

Quantity: 1

Specification:

Unit to be shape and size as shown on plan and in detail. Unit to feature 14-gauge stainless steel. All vertical and horizontal corners to be coved on a 3/4" radius, meeting in spherical sections. Polished to a #4 satin finish. Front of unit to be totally flush welded. Backsplash to be 10" high with 2" return to wall at 45° with ends closed. Unit to have a 180° raised rolled rim on front and both ends. Drainboards to be 14-gauge stainless steel and shall be pitched and welded integral to unit. Sink partitions to be 5/8" thick 14-gauge stainless steel double wall construction. Understructure of unit to be 14-gauge triangular channeling welded to bottom. To include provisions for two faucets. Bottom of each sink to be die stamped with a 3-1/2" opening and depressed to accept a 2" lever operated waste with built-in overflow. Sink to rest on stainless steel legs, stainless steel gussets, and stainless steel adjustable bullet feet. Unit shall come complete with three (3) 2" lever operated waste assemblies with built-in overflows, two (2) T&S model B-0231-CC splash mounted faucets.

Each sink bowl to measure 20" x 28" x 14" deep. Drainboards to be 24" long. Overall length to be about 9'-0".

Item #: 9

Description: Pot Rack, Wall Mounted

Manufacturer: Advance/Tabco

Model #: SW-96

SIS #: T037

Quantity: 1

Alternate Manufacturer: Eagle, Fabricated

Specification:

Unit to be model SW-96 Stainless Steel Pot Rack as manufactured by Advance/Tabco and with the following features: Unit to be secured to wall by means of bolts through welded brackets. Materials: Flat steel bar is 2" x 1/4" stainless steel. 18 plated pot hooks included. Construction: All welded stainless steel blended to a satin finish.

Item #: 10

Description: Hand Sink

Manufacturer: Advance/Tabco

Model #: 7-PS-90

SIS #: T037

Quantity: 3

Alternate Manufacturer: Eagle

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Specification:

Unit to be model 7-PS-90 Stainless Steel Hand Sink with Pedestal Base as manufactured by Advance/Tabco and with the following features:

One piece Deep Drawn sink bowl design. Countertop die formed recessed edge offers the ultimate in design and function. All sink bowls have a large liberal radii with a minimum dimension of 2" and rectangular in design for increased capacity.

Material: Heavy gauge type 304 series stainless steel. Wall mounting bracket is stainless steel and of offset design. All fittings are brass/nickel plated unless otherwise indicated.

Mechanical: Faucet supply is 1/2" IPS male thread hot and cold. Foot pedal splash mounted 4" O.C. gooseneck faucet chrome plated furnished with aerator. K-6 stainless steel basket drain 1-1/2" IPS. Sink bowl is 10" x 14" x 5" deep.

Construction: All TIG welded. Welded areas blended to match adjacent surfaces and to a satin finish. Die formed Countertop Edge with a 3/8" No-Drip offset. One sheet of stainless steel is used. There are no welded seams other than corners.

Unit to be complete with Pedestal Base and Foot Pedal Faucet.

Item #: 11

Description: Spare Number

Manufacturer: None

Model #: None

SIS #: T037

Quantity: 0

Specification:

Item #: 12

Description: Shelving Unit

Manufacturer: Cambro

Model #: Elements Series

SIS #: T037

Quantity: 2

Alternate Manufacturer: Metro

Specification:

Each unit to be a 4-Shelf Cambro Elements Series Starter Stationary Unit with the following features: Shelf Plates only with Camguard antimicrobial. 3 Post Heights 64", 72", 84". 3 Shelf Widths 18", 21", 24". 5 Shelf Lengths 36", 42", 48", 54", 60".

Each Starter Unit shall include: 4 stationary posts with leveling feet installed pre-assembled with post connectors and wedges, 1 bag of 32 stationary traverse dovetails (16 ea. A and B), Vented shelf plates (for 4 shelves), 8 stationary traverses and instructions.

Posts: Proprietary non-corrosive composite material. Post Connectors: Glass Filled Polypropylene. Traverses: Proprietary non-corrosive composite material. Vented/Solid Shelf Plates: Reinforced polypropylene with Camguard antimicrobial. Corner Connectors: Glass Filled Polypropylene. Adjustable Foot: Glass Filled Nylon. Seismic Foot: Stainless Steel post and wide foot plate, 3 holes for bolts. (Bolts not provided) Divider Bars: Glass Filled Nylon. Wall Fastener: Stainless Steel. Dovetails: Resin Nylon Wedges: Resin Polypropylene

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- (1) One unit at 18" x 42" x 72" high. (model # ESU184272V4)
- (1) One unit at 21" x 48" x 72" high. (model # ESU214872V4)

Item #: 13

Description: Convection Oven, Double

Manufacturer: Blodgett

Model #: DFG-100-ES-Double

SIS #: T037

Quantity: 2

Alternate Manufacturer: Garland, Southbend, Vulcan

Specification:

Unit to be a model DFG-100-ES-Double full-size convection oven double compartment as manufactured by Blodgett and with the following features:

Each compartment shall have porcelainized steel liner and shall accept five 18" x 26" standard full-size bake pans. Stainless steel front, top and sides. Doors shall be dual pane thermal glass windows with single powder coated handle and simultaneous operation. Unit shall be gas heated with electronic spark ignition and shall cook by means of a direct fired system with a gas shutoff switch on the front of the control panel. Air in baking chamber distributed by single inlet blower wheel powered by a single speed, 3/4 HP motor with thermal overload protection. Each chamber shall be fitted with two halogen lamps, five chrome-plated removable racks and removable crumb trays. Control panel shall be recessed with solid state digital control with LED display, Cook & Hold and Pulse Plus. Unit is provided with a three-year parts, two-year labor and five-year door warranty.

Each unit to be complete with the following options and accessories:

- (1) One set of 6" casters.
- (1) One gas manifold for double sections.
- (1) One Dormont model 1675KITCFS48PS, 48" long, 3/4" flexible gas hose with quick disconnect, restraining device and Posi-Set.

Item #: 14

Description: Range, 6-Burner

Manufacturer: Vulcan

Model #: 36S-6BN

SIS #: T037

Quantity: 1

Alternate Manufacturer: Garland, Jade, Southbend

Specification:

Unit to be model 36S-6BN 36" wide gas restaurant range, model 36S-6BN as manufactured by Vulcan and with the following features:

Fully MIG welded aluminized steel frame for added durability. Stainless steel front, sides, backriser, highshelf and 6" adjustable legs. Extra deep crumb tray with welded corners. Six

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30,000 BTU/hr. open top burners with lift-off burner heads. Energy saving flashtube open burner ignition system (one pilot for every two burners) shrouded for reliability. Heavy duty cast grates, easy lift-off 12" x 12 1/2" in the front and 12" x 14 1/2" in the back to better accommodate stock pots or large pans. Grates have a built-in aeration bowl for greater efficiency. Burner knobs are cool to the touch, high temperature material. One oven: 35,000 BTU/hr. standard bakers' depth ovens with porcelain oven bottom and door panel, measures 27"d x 26 3/8"w x 14"h. Oven thermostat adjusts from 250°F to 500°F with a low setting. Oven is supplied with two racks, two rack guide sets, and four rack positions. Oven door is heavy duty with an integrated door hinge/spring mechanism requiring no adjustment. 3/4" rear gas connection and pressure regulator. Total input 215,000 BTU/hr.

Exterior Dimensions: 34"d x 36"w x 58"h on 6" adjustable legs.

Unit to be complete with the following options and accessories:

- (1) One set of 6" casters.
- (1) One Dormont model 1675KITCFS48PS, 48" long, 3/4" flexible gas hose with quick disconnect, restraining device and Posi-Set.

Item #: 15

Description: Steamer, Double

Manufacturer: AccuTemp

Model #: E62083E170DBL

SIS #: T037

Quantity: 1

Specification:

Unit to be model E62083E170DBL stacked, stand-mounted Evolution 6-pan electric boilerless convection steamer as manufactured by AccuTemp and with the following features:

- Fast cook times with patent-pending Steam Vector Technology, which utilizes no moving parts.
- Cook mode and Variable Hold Temperature mode.
- Easy-to-use digital controls, with digital temperature display.
- Independent digital electronic timer with programmable preset.
- Simple water and drain connections.
- No water filtration or treatment required.
- No warranty exclusions for water quality.
- Uses less than 1.5 gallons of water per hour.
- Front-mounted drain valve.
- No scheduled de-liming or maintenance.
- Heavy-duty, field-reversible door.
- Door can be opened at any time during cooking cycle.
- Cast aluminum heating element is not exposed to water.
- Multiple kW heat inputs available for all cooking needs.
- Steamer cavity constructed of reinforced 14 ga. 304 stainless steel.
- Easy-to-clean control panel.
- Automatic altitude compensation.
- Dishwasher-safe one-piece wire pan racks.

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- Dishwasher-safe SVT steam collector and distributor panels.
- Dishwasher-safe front-mounted condensate tray.
- English and Spanish operating instructions on door.
- Simplified service access panel.
- Low water, high water and overtemp indicator lights.
- (2) 5' power cords and plugs included, separate receptacle needed for each unit.
- One year parts and labor warranty.
- Lifetime Service & Support Guarantee.
- UL LISTED Safety Certification (UL 197).
- UL EPH Sanitation Certification (NSF 4).

Item #: 16

Description: Exhaust Hood

Manufacturer: Captive-Aire

Model #: 7224ND-2-PSP-F

SIS #: T037

Quantity: 2

Specification:

Units to be model 7224ND-2-PSP-F 7'-11" long exhaust-only wall canopy hood with front perforated supply plenum with built-in 3" back standoff as manufactured by Captive-Aire and with the following features:

Unit to be size and shape as shown on plans and in details.

Description: The model ND is a Type I, double island, exhaust canopy used for collection and removal of grease-laden vapors and smoke over all types of restaurant equipment.

Application: The hood shall provide flexibility in designing kitchen ventilation equipment and shall be tested and listed for use over 450°F light/medium duty cooking surfaces; 600°F heavy duty cooking surfaces; and up to 700°F extra heavy duty cooking surfaces.

Construction: The hood shall be constructed of type 430 stainless steel with #3 or #4 polish where exposed. All seams shall be welded or in conformance with UL 710 standards. Unexposed surfaces shall be constructed of aluminized steel, Individual component construction shall be determined by manufacturer and ETL, Construction shall be dependent on the structural application to minimize distortion and other defects. All seams, joints and penetrations of the hood where grease-laden vapors and exhaust gases are present must be liquid-tight, continuous external weld in accordance with NFPA 96.

The hood shall be constructed to include: A double wall insulated front to eliminate condensation and increase rigidity. The insulation shall have a flexural modulus of 475 EI, meet UL 181 requirements and be in accordance with NFPA90A and 90B. An Integral front baffle to direct grease laden vapors toward the exhaust filter bank. An integral grease drain system on the hood back with a minimum 1/8" per foot slope, to include an exposed, removable 1/2-pint grease cup to facilitate cleaning. A built-in wiring chase for electrical controls on the front face of the hood designed to avoid penetration of the capture area and eliminate the need for an external chaseway. UL Incandescent light fixtures and globes, allowing up to a 100-watt standard light bulb, installed and pre-wired to a junction box and installed with a maximum of 3'-6" spacing on center. Exhaust duct collar 4" high with 1" flange. A minimum of four connections for hanger rods. Connectors shall have 9/16" holes pre-punched in 1-1/2" x 1-1/2" angle iron at the factory to allow for hanger rod connection by others. UL Classified aluminum baffle filters, with size and quantity

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determined by the hood's dimensional parameters, but extending the full length of the hood with filler panels not to exceed 6".

Certification: The hood shall be ETL Listed, comply with UL 710 Standards and shall be built in accordance with NFPA96. Hood shall be tested for compliance with the ETL Sanitation Mark.

Documentation: Manufacturer shall furnish complete computer generated submittal drawings including hood section view(s), plan view(s), duct sizing, and CFM and static pressure requirements. Static pressure, air velocity and air volume requirements indicated on drawings shall be precise and accurate and hood shall perform to said specifications. Drawings shall be available to the engineer, architect and owner for their use in construction, operation and maintenance.

The hood shall contain a factory engineered and pre-piped, U.L. Listed, Wet Chemical, Ansul R-102 fire suppression system. The system piping shall be installed in the hood at the time of construction by Captive-Aire. Piping shall be installed above the hood and shall be concealed from view. No exposed piping is acceptable, with the exception of the appliance drops. A certified local Ansul distributor shall be selected by the factory for final system hook-up. The hood manufacturer shall be responsible for the coordination between the contractor and Ansul distributor for the final field hook-up and certification of the fire suppression system.

The system shall be capable of automatic detection and actuation and/or remote manual actuation. The system shall have the fire suppression capabilities to protect the duct(s), plenum(s), filter area(s) and cooking equipment. Accessories shall be available for mechanical or electrical gas line shut-off applications and a double-pole, double-throw micro switch for activation of a shunt trip breaker (provided by others) for electrical equipment. The system shall also include the release assembly, agent tank, detectors, fusible links, liquid tight fittings, 1-1/4" mechanical gas valve, recessed remote manual pull station, and schedule 40 black iron pipe with chrome sleeving for exposed areas.

The hood shall be complete with the following options and accessories:

- 430 Stainless Steel where exposed.
- Insulation for the PSP housing – front.
- Fire cabinet wall-mounted.
- Filters – (5) Five 20" tall x 16" wide stainless steel Captrate Solo filter with hook, ETL Listed. Particulate capture efficiency: 93% efficient at 9 microns, 72% efficient at 5 microns.
- (3) Three L55 series E26 canopy light fixture – high temp assembly. Includes clear thermal and stock resistant globe (L55 Fixture).
- Exhaust Riser – Factory installed 14" diameter x 4" height.
- Supply Riser – 8" x 36" supply riser with volume dampers.
- ½ pint grease cup new style, flanged slotted.
- Field wrapper: 6" high, front, left and right.
- (2) Two Backsplash: 54" high x 96" long 430 stainless steel horizontal. (Includes end caps and divider bars.
- (1) Right Sidesplash: 80" high x 42" long 430 stainless steel horizontal. (Includes end caps and divider bars.
- (1) One Left Sidesplash: 80" high x 42" long 430 stainless steel horizontal. (Includes end caps and divider bars.
- (1) One Right End Standoff (Finished) 1" wide 72" long insulated.
- (1) One Left End Standoff (Finished) 1" wide 72" long insulated.
- (1) One Electrical package installation in utility cabinet by Captive-Aire.

Hood to be complete with a Demand Control Ventilation Electrical System:

Application: The Demand Control Ventilation System (DCV) is designed to automatically reduce exhaust and supply airflow quantities, while ensuring hood performance is maintained. The DCV uses Variable Frequency Drives (VFD) and temperature sensors in the exhaust ducts to modulate the fans speed during cooking operation and maximize energy savings. The LCD screen interface provides fan(s) control, system configuration, and diagnostic information.

Construction:

The DCV includes:

- Smart Controller
- LCD Screen Interface
- Duct Temperature Sensor(s)
- Room Temperature Sensor
- Variable Frequency Drive(s)

Controls shall be listed by ETL (UL 508A).

The system includes a LCD screen interface for fan(s) and hood lights control, wash control (if applicable), gas valve reset, programmable schedule, Max Air Override function, Preparation Time mode, Cool Down mode, and diagnostics including VFD status. The LCD screen shows descriptive plain text explaining the functions or values.

The LCD screen interface will be installed on the face of the hood, on the face of the utility cabinet or on the face of a wall mounted control enclosure.

Control enclosure will be NEMA 1 rated and listed for installation inside of the exhaust hood utility cabinet. Control enclosure may be constructed of stainless steel or painted steel.

The smart controller will constantly monitor the exhaust air temperature through the riser mounted temperature sensor and modulate the fan speeds accordingly.

A room temperature sensor will also be provided for field installation in the kitchen space in order to start the fan(s) based on the temperature differential between the room and the exhaust air in the duct rather than fixed set-points.

A Preparation Time Mode is available for morning operation: dedicated make-up air will be locked out only allowing the use of transfer air during this mode. Exhaust fan(s) will run at low CFM while maintaining a balanced kitchen pressure.

A Cool Down Mode is designed for equipment cool-down period at the end of the daily cooking operations: similarly to Preparation Time mode, dedicated make-up air will be locked out only allowing the use of transfer air during this mode. Exhaust fan(s) will run at low CFM while maintaining a balanced kitchen pressure.

Fan maximum/ minimum speeds will be adjustable for proper kitchen balance. Fan direction change is also available from the smart controller configuration menu without need for rewiring.

Duct Temperature Sensor(s) will be mounted in the exhaust hood riser(s). Temperature probe will be constructed of Stainless Steel. System will be factory pre-set to modulate fan speed within a range of 45°F for 600°F and 700°F cooking applications and a range of 5°F for 400°F cooking applications. Set points are fully adjustable through the touch screen interface based on application needs.

The Max Air Override will have an adjustable timeout value.

The panels include color-coded wiring with as-built wiring diagrams and spare terminals controlled by the fire system micro switch. The panel is factory pre-wired to shut supply fans down in a fire condition. Options to turn ON the exhaust fans or turn off the hood lights in a fire

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condition will be configurable through the smart controller, but only through a password protected menu to prevent any changes after a fire inspection has been performed.

Item #: 17

Description: Spare Number

Manufacturer: None

Model #: None

SIS #: T037

Quantity: 0

Specification:

Item #: 18

Description: Spare Number

Manufacturer: None

Model #: None

SIS #: T037

Quantity: 0

Specification:

Item #: 19

Description: Sheet Pan Rack

Manufacturer: Advance/Tabco

Model #: PR18-3W

SIS #: T037

Quantity: 2

Alternate Manufacturer: Channel, Cres-Cor, Piper Products

Specification:

Unit to be model PR18-3W Pan Rack as manufactured by Advance/Tabco. Unit to feature curved top design. Heavy duty welded construction with 6 cross supports. 1" x 1-1/2" ribbed angles. Heavy duty 5" stem bolted swivel casters. 500 lbs capacity. Construction to be fully welded 1" square tubing ladder assembly. Angles are 1" x 1-1/2" x 20" on front load racks. Material to be 6063-T52 extruded aluminum angles, upright tubing, and support pieces.

Item #: 20

Description: Refrigerator, 2-Section, Roll-In

Manufacturer: Continental

Model #: DL2RI-E

SIS #: T037

Quantity: 1

Alternate Manufacturer: Traulsen, Victory

Specification:

Unit to be model DL2RI-E 2-Section Extra-High Roll-In Refrigerator with 72" Cart Capacity as manufactured by Continental Refrigerator and with the following features:

Refrigeration System:

A "performance rated", air-cooled, hermetically sealed, capillary-type refrigeration system is installed on the top of each refrigerator. Plasticized fin coil and air circulation fans are contained within a concealed "plug"-type insulated housing, readily accessible on top of the cabinet and separate from the food zone to increase food storage capacity. The entire "plug" system is fully charged with environmentally safe R-134a refrigerant and mounted on a sturdy steel, rail-type base which can be easily removed if freezer conversion is desired. Refrigerators are designed to maintain 38°F-40°F (3°-5° Centigrade) while operating with an unrestricted air supply in a maximum ambient temperature of 100°F. All condensate water is evaporated by an automatic, non-electric, corrosion-resistant condensate evaporator. A strict quality-assurance team inspects all materials and components to certify that each model conforms to the most exacting standards. All models are factory performance-tested for a minimum of 16 hours prior to crating.

Insulation:

All cabinet walls, top and bottom have high density, foamed-in-place, non-CFC polyurethane insulation.

Cabinet Construction:

All materials are of top quality, assembled to conform with strict quality-assurance requirements. The cabinet front is constructed of heavy-gauge polished stainless steel for durability. All cabinet joints and seams are sealed vapor-tight. Case is of all metal, welded construction and internally supported and braced for a rigid unit construction. Cabinet design eliminated overlapping panels with raw edges. Cabinet body is insulated with non- CFC, foamed-in-place polyurethane foam with an average thickness of 3 inches to ensure increased energy efficiency. Full-length louvered air grille located above the doors allows equal air circulation to the condensing unit. Easily removable, low-wattage, anti-sweat door heaters concealed by a non-metallic, non-conductive, high-impact thermal breaker strip eliminate condensate build-up on the cabinet front. Automatic interior lighting is controlled by door openings. Cabinets are equipped with an easily removable, stainless steel ramp and interior rack guides.

Door Construction:

Solid hinged door shells are constructed of heavy-gauge stainless steel and are internally braced and urethane-foam-insulated for rigidity. Door corners are welded construction and polished. Replaceable snap-in door gaskets are self-adjusting, heavy-duty, magnetic type. Door handles and hinges are chrome-plated and non-corrosive. Doors are provided with built-in cylinder locks which are keyed alike. Hinges are cam action, lift-off type featuring positive safety stop at 120 degrees.

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Item #: 21

Description: Work Table
Manufacturer: Fabricated
Model #: Custom
SIS #: T037
Quantity: 2

Specification:

Each unit shall be of size and shape as shown on plan and in detail. 8'-0" long x 36" wide x 36" high to work surface. Unit to feature 14-gauge stainless steel top, rolled edge on all four sides with "Bull Nosed" corners and polished to a #4 satin finish. Understructure to be rigidly braced with stainless steel channeling. Table shall have stainless steel undershelf with corners notched and welded to stainless steel legs. Unit to have stainless steel gussets and adjustable bullet feet. Unit shall come complete with (1) one double pan drawer assembly located as per plan. All construction as per general specifications.

Item #: 22

Description: Rethermalization Cabinet
Manufacturer: F.W.E
Model #: RH-18
SIS #: T037
Quantity: 2
Alternate Manufacturer: Cres-Cor, Carter-Hoffmann, Winston

Specification:

Units to be model RH-18 Rethermalization Cabinets as manufactured by Food Warming Equipment and with the following features:

Construction:

Heliarc welded, single unit construction of stainless steel; 18-gauge polished exterior, 18-gauge stainless steel interior with easy-to-clean coved corners. Welded tubular base frame shall be 1" square, heavy gauge stainless steel tubing, with 10-gauge stainless steel reinforcing plates at corners.

Insulation:

"Ultra-Guard" UG-26 high density fiberglass insulation throughout; top, back, bottom, sides, and door(s), with a minimum of 2" and up to 4".

Door and Latch:

Flush mounted, stainless steel double pan stainless steel insulated gasketless door(s). Heavy-duty edge mount full grip magnetic door latch with heavy-duty hinges. Three (3) die-cast edgemount hinges per door.

Casters:

Maintenance free polyurethane tire casters in a configuration of two (2) rigid and two (2) swivel with brake. Casters shall have a reinforced yoke mounted to 10-gauge caster plate. The caster mounting plate shall be secured to a 10-gauge stainless steel reinforcing stress plate via welded in place stainless steel studs. The reinforcing stress plates shall be welded to the heavy gauge tubular frame of the unit.

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Trayslides:

Welded rod-style tray slides are chrome plated and epoxy coated for greater durability and sanitation. Fully adjustable / removable and designed to give secure bottom tray support. Removable stainless steel uprights shall be punched on 1.5" spacings, o.c., for easy tray adjustment, and shall easily lift off heavy-duty stainless steel brackets without the use of tools for cleaning.

Heating System:

Built-in heat system includes multiple Incoloy sheathed heating elements that provide fast heat up and accurate temperature set points. In heat cycle, elements provide full power to assure safe reheat times. When heat time expires, unit to automatically switch to hold mode maintaining food quality and safe holding temperatures. Unit contains internal cooling fans and thermally protected blower motors, safety switches and control panel is temperature rise protected. Unique precision venting baffle duct system for even, efficient heat throughout the entire cabinet, in either heat or holding periods. Venting may be required. Local codes prevail.

Control Panel:

Automatic controls include PREHEAT with override capability, PAUSE feature, TIME counting and timer that automatically switches from Heat Cycle to Hold Cycle. Adjustable HEAT control up to 350°F (121°C) with adjustable HOLDING control up to 190°F (90°C) and E-Z Recall of original set points. Shall include ON / OFF switch. Actual cabinet temperature reading is LED displayed during each cycle. Unit can function by timer or by probe (Probe ready; Probe not included.) Consult factory if lower temperature is required for local codes.

Electrical Characteristics:

208-Volt, 3-Phase, 11.11-Kw., 27.6-Amps, Cord and Plug (NEMA 15-30P)

Installation:

Unit should not be installed in an area where adverse environmental conditions are present.

Item #: 23

Description: Spare Number

Manufacturer: None

Model #: None

SIS #: T037

Quantity: 0

Specification:

Item #: 24

Description: Work Table with Sink

Manufacturer: Fabricated

Model #: Custom

SIS #: T037

Quantity: 1

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Specification:

Unit to be size and shape as shown on plan and in detail. 9'-0" long x 30" wide x 36" high to work surface. Unit to feature 14-gauge stainless steel top, marine edged on three sides with 10" high backsplash with 2" return to wall at 45° with ends closed. Top to be polished to a #4 satin finish. Understructure to be rigidly braced with stainless steel channeling. Table to have two (2) stainless steel undershelves with corners notched and welded to stainless steel legs. Area below sinks to remain open for installation of plumbing. Unit to have stainless steel gussets and adjustable bullet feet. Table shall come complete with (2) two 20" x 20" x 12" deep coved corner sink bowls with 2" lever waste with built-in overflow. Unit shall come complete with (1) one T&S Brass model B-0231-CC splash mounted mixing faucet with swivel gooseneck nozzle.

Item #: 25

Description: Wall Shelf

Manufacturer: Advance/Tabco

Model #: WS-12-108-16

SIS #: T037

Quantity: 2

Alternate Manufacturer: Eagle, Fabricated

Specification:

Unit to be model WS-12-108-16 Wall Shelf as manufactured by Advance/Tabco and with the following features: Shelf shall be furnished with a 1-1/2" sanitary downward rolled rim on front with a 1-1/2" turn-up edge at rear. Ends are turned down square. Unit shall be constructed of 16-gauge type "430" stainless steel. Units shall be secured to the wall by means of stainless steel bolts through welded support brackets. Brackets can be positioned to accommodate wall studs. Units 7 ft. and larger are furnished with 3 brackets

Item #: 26-29

Description: Spare Number

Manufacturer: None

Model #: None

SIS #: T037

Quantity: 0

Specification:

Item #: 30

Description: Milk Cooler

Manufacturer: Beverage Air

Model #: SMF58-W

SIS #: T037

Quantity: 2

Alternate Manufacturer: Continental, Delfield, True

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Specification:

Unit to be model SMF58-W Single Access, Forced-Air milk cooler as manufactured by Beverage Air and with the following features:

Units are designed to keep milk cold during prolonged serving periods. A continuous cold-air blanket over the milk containers keeps the milk cold and drinkable under 38°F during serving.

Cabinet Construction:

Standard construction includes the lid, door, adjustable hinges, and door latches made from stainless steel. Balance of exterior is white finish on steel. One-piece, reinforced stainless steel floor for maximum milk crate support. Balance of interior is galvanized steel. Heavy-duty, epoxy coated steel wire floor racks are provided for added floor protection. Floor drain is centrally located for easy cleaning, connecting to drain hose with hose adapter. Exterior thermometer, cylinder lock, bottom drain, and 4" swivel casters (2 with locks) are provided as standard. Foamed-in-place CFC and HCFC-free polyurethane insulation enhances the structural strength of the cabinet and helps increase energy efficiency. This insulation helps to prevent liquid penetration that results in foul odors. Overall depth of 31 1/2" allows easy mobility and clear passage through most doorways. Models are also offered with stainless steel exterior in place of white finish on steel.

Refrigeration System:

Refrigeration system uses R134a refrigerant, which is CFC and HCFC-free for compliance with environmental safety concerns.

Electrical:

Units wired at factory and ready for connection to a 115/60/1 phase, 15 amp dedicated outlet. 8' long cord and plug set included.

Special Features:

One-piece, reinforced stainless steel floor for maximum support of milk crates.

Item #: 31

Description: Serving Counter, Flat Top

Manufacturer: Delfield

Model #: SC-36-NU

SIS #: T037

Quantity: 2

Alternate Manufacturer: LTI, Piper Products, Randell

Specification:

Unit to be model SC-36-NU All Purpose Counter as manufactured by Delfield and with the following features:

Exterior body is constructed of 18-gauge stainless steel side panels and 14-gauge galvanized bottom. All exterior side panels are reinforced with overlapping corners and are welded in place. All body cutouts are reinforced with 14-gauge galvanized channel supports.

Exterior top is constructed of 14-gauge stainless steel, welded, ground and polished into one integral unit. Top is fabricated with square exterior corners.

Casters unit is mounted on 5" (12.7cm) diameter swivel casters with non-marking polyolefin tires and plate brakes. Overall height of caster assembly is 6" (15.2cm).

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Unit to be complete with the following options and accessories:

- (1) One (B) 12" wide stainless steel fold down tray slide.
- (1) One (F) Line-up interlock device.
- (1) One (P) Open understorage with shelf.
- (1) One (V) 6" high adjustable stainless steel legs in lieu of casters.
- (1) One (X) Laminate exterior in lieu of stainless steel.

Item #: 32

Description: Serving Counter, Hot Food

Manufacturer: Delfield

Model #: SC-74-Modified

SIS #: T037

Quantity: 2

Alternate Manufacturer: LTI, Piper Products, Randell

Specification:

Unit to be model SC-74-NU All Purpose Counter as manufactured by Delfield and with the following features:

Exterior body is constructed of 18-gauge stainless steel side panels and 14-gauge galvanized bottom. All exterior side panels are reinforced with overlapping corners and are welded in place. All body cutouts are reinforced with 14-gauge galvanized channel supports.

Exterior top is constructed of 14-gauge stainless steel, welded, ground and polished into one integral unit. Top is fabricated with square exterior corners.

Casters unit is mounted on 5" (12.7cm) diameter swivel casters with non-marking polyolefin tires and plate brakes. Overall height of caster assembly is 6" (15.2cm).

Each unit to be complete with the following options and accessories:

- (1) One (B) 12" wide stainless steel fold down tray slide.
- (1) One (F) Line-up interlock device.
- (2) Two Mechanical access doors.
- (2) Two Custom heated racks with mechanical access doors to each dispenser with locks. Cutout size to be 27.50" x 19.88". 120V-60C-1PH-12.7A (Hard Wired). Unit must have bottom support. Provided with lift off lids for openings with locks and closed corners.
- (1) One (V) 6" high adjustable stainless steel legs in lieu of casters.
- (1) One (X) Laminate exterior in lieu of stainless steel.
- Electrical: 120/208-230V-60-1PH-12.7A, 9' cord and plug (NEMA 14-20P)

Item #: 33

Description: Tray Stand

Manufacturer: Delfield

Model #: SCTS-36

SIS #: T037

Quantity: 2

Alternate Manufacturer: LTI, Piper Products, Randell

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Specification:

Units to be model SCTS-36 Mobile Tray and Silver Stands as manufactured by Delfield and with the following features:

Exterior body is constructed of 18-gauge stainless steel side panels and 14-gauge galvanized bottom. All exterior side panels are reinforced with overlapping corners and are welded in place. Stress points are reinforced with 14-gauge galvanized channel supports.

Exterior top is constructed of 14-gauge stainless steel, welded, ground and polished into one integral unit. Top is fabricated with square exterior corners. Top has area for silverware with stepdown for trays.

Casters; unit is mounted on 5" (12.7cm) diameter swivel casters with non-marking polyolefin tires and plate brakes. Overall height of caster assembly is 6" (15.2cm).

Unit to be complete with the following options and accessories:

- One (SW) Silverware cutouts with stainless silverware holders. (8)
- One (X) Laminate exterior panels in lieu of stainless steel.

Item #: 34

Description: Serving Counter, Salad Bar

Manufacturer: Delfield

Model #: SCSC-74-B

SIS #: T037

Quantity: 1

Alternate Manufacturer: LTI, Piper Products, Randell

Specification:

Unit to be model SCSC-74-B Mobile Self-Contained Cold Pan Serving Counter as manufactured by Delfield and with the following features:

Exterior body is constructed of 18-gauge stainless steel side panels and 14-gauge galvanized bottom. All exterior side panels are reinforced with overlapping corners and are welded in place. All body cutouts are reinforced with 14-gauge galvanized channel supports.

Exterior top is constructed of 14-gauge stainless steel, welded, ground and polished into one integral unit.

The refrigerated cold pan is 7" (18cm) deep and constructed of stainless steel to hold 4" deep pans. The cold pan is separated from the exterior top by a thermal break. Copper refrigeration tubing is attached to the sides of the cold pan and is fully insulated with foamed in place environmentally friendly, Kyoto Protocol Compliant, Non ODP (Ozone Depletion Potential), Non GWP (Global Warming Potential) polyurethane insulation. Cold pan is equipped with a 1" (2.5cm) I.P.S. drain with drain valve located at the bottom of the unit. Temperatures of 33°F (1°C) to 41°F (5°C) are maintained with pans recessed 2" (5cm) at 86°F ambient room temperature. Pans rest on die-stamped cold pan. Pans by others.

Refrigeration system uses HFC-404A refrigerant and has a self-contained 115 volt, 60 Hertz, single phase hermetically sealed condensing unit with adjustable cold pan pressure control. Unit is wired with a 3-wire, grounded, maximum 10' (3m) cord and plug. Unit has an on/off switch mounted on the exterior.

Casters: Unit is mounted on 5" (13cm) diameter swivel casters with non-marking tires and plate brakes. Overall height of caster assembly is 6.00" (15cm).

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Unit to be complete with the following options and accessories:

- (2) Two (B) 12" wide stainless steel fold down tray slide.
- (1) One (F) Line-up interlock device.
- (1) One (KD) Dual Service food protector.
- (1) One (X) Laminate exterior in lieu of stainless steel.

Item #: 35

Description: Serving Counter, Cashier Stand

Manufacturer: Delfield

Model #: SCS-50

SIS #: T037

Quantity: 1

Alternate Manufacturer: LTI, Piper Products, Randell

Specification:

Unit to be model SCS-50 Mobile Cashier's Counter as manufactured by Delfield and with the following features:

Exterior body is constructed of 18-gauge stainless steel side panels and 14-gauge galvanized bottom. All exterior side panels are reinforced with overlapping corners and are welded in place. All body cutouts are reinforced with 14-gauge galvanized channel supports.

Interior Lining at the cashier's end is 18-gauge stainless steel, with a stainless-steel bottom shelf. Unit has a 16.50" x 16.50" x 5.00" (42cm x 42cm x 13cm) stainless steel cash drawer with lock and key.

Exterior top is constructed of 14-gauge stainless steel, welded, ground and polished into one integral unit. Top is fabricated with square exterior corners. A 2.00" (5cm) ferruled hole is located at the rear of the top to allow cord access for cash registers.

Casters; unit is mounted on 5.00" (13cm) diameter swivel casters with non-marking polyolefin tires and plate brakes. Overall height of caster assembly is 6.00" (15cm).

Unit to be complete with the following options and accessories:

- (2) Two (B) 12" wide stainless steel fold down tray slide.
- (1) One (F) Line-up interlock device.
- (1) One 120-Volt, 10-Amps convenience outlet with breaker.
- (1) One (X) Laminate exterior in lieu of stainless steel.

Item #: 36

Description: Shelving Unit

Manufacturer: Cambro

Model #: Elements Series

SIS #: T037

Quantity: 7

Alternate Manufacturer: Metro

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Specification:

Each unit to be a 4-Shelf Cambro Elements Series Starter Stationary Unit with the following features: Shelf Plates only with Camguard antimicrobial. 3 Post Heights 64", 72", 84". 3 Shelf Widths 18", 21", 24". 5 Shelf Lengths 36", 42", 48", 54", 60".

Each Starter Unit shall include: 4 stationary posts with leveling feet installed pre-assembled with post connectors and wedges, 1 bag of 32 stationary traverse dovetails (16 ea. A and B), Vented shelf plates (for 4 shelves), 8 stationary traverses and instructions.

Posts: Proprietary non-corrosive composite material. Post Connectors: Glass Filled Polypropylene. Traverses: Proprietary non-corrosive composite material. Vented/Solid Shelf Plates: Reinforced polypropylene with Camguard antimicrobial. Corner Connectors: Glass Filled Polypropylene. Adjustable Foot: Glass Filled Nylon. Seismic Foot: Stainless Steel post and wide foot plate, 3 holes for bolts. (Bolts not provided) Divider Bars: Glass Filled Nylon. Wall Fastener: Stainless Steel. Dovetails: Resin Nylon Wedges: Resin Polypropylene

- (2) Two units at 21" x 36" x 72" high. (model # ESU213672V4)
- (2) Two units at 21" x 42" x 72" high. (model # ESU214272V4)
- (3) Three units at 21" x 48" x 72" high. (model # ESU214872V4)

Item #: 37

Description: Trash/Recycle/Compost Cart

Manufacturer: Lakeside

Model #: SP-5678

SIS #: T037

Quantity: 1

Specification:

Unit to be model SP-5678 Trash, Recycle, & Compost Station as manufactured by Lake side and with the following features:

Unit to be 64.77" long x 24.40" wide x 33.36" high to work surface. Unit shall be of welded stainless steel construction and shall have 20-gauge sides and 18-gauge top. Interior compartment floor shall be 18-gauge stainless steel. Units shall have (3) three specific chute openings to accept waste/refuse, recyclables (plastic bottles/aluminum cans), and compost. Chute openings shall have symbols indicating function on sign feature above. Units shall have (4) four 5" swivel casters, two with brakes. Hinged compartment doors shall have full-length finger grip and magnetic closure latch. Unit to accommodate and be complete with (3) three 35-gallon capacity waste containers, (1) waste chute, (1) recycle chute, (1) compost chute each with a 10" x 14" rectangle opening. Top to have marine edge on all four sides. Exterior to be clad in a plastic laminate. (color to be selected by architect) Unit to be complete with overhead signage which will indicate which chute for each type of waste. Signage to be supported by stainless steel posts.

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Item #: 38

Description: Walk-In Freezer

Manufacturer: Kolpak

Model #: Custom

SIS #: T037

Quantity: 1

Alternate Manufacturer: American Panel, Bally, Thermo-Kool

Specification:

General: Walk-in coolers and/or freezers provided under this portion of the specifications shall be prefabricated of modular design and construction. They shall be designed to allow convenient and accurate field assembly and future enlargement by the addition of panels.

Exterior Size: To be 15'-5" wide by 10'-7 1/2" deep by 8'-6 1/4" high with floor.

Panel Fabrication: Standard wall, ceiling and floor panels shall be 11-1/2", 23", 34-1/2", and 46" in width and shall be interchangeable with like panels. Corner panels shall be 90 degree angles with actual 12" exterior horizontal measurements. Panels shall consist of foamed-in-place urethane insulation, sandwiched between interior and exterior metal surfaces, which has been die-formed and gauged for uniformity in size. Edges of panels shall be foamed-in-place "tongue and groove" with "Posi-Loc" locking assemblies foamed-in-place at time of fabrication.

Floor Construction: Walk-in to be supplied with a 16-gauge smooth galvanized steel floor: Panels shall be fabricated similar to other panels in the walk-in with panel edges to have foamed-in-place tongue and groove with Posi-Loc locking assemblies foamed-in-place at time of fabrication with distance between locks not to exceed 46 inches. Floor surface to be smooth galvanized steel and designed to readily withstand uniformly distributed loads of 700 lbs. per square foot. All edges and corners to be coved in accordance with NSF Standard 7 and completely foamed-in-place. All panel joints shall be sealed with PVC bubble gasketing to be foamed-in-place and not glued or stapled. Floor will be recessed in a 6" deep slab depression.

Insulation: Insulation shall have a 97% closed cell structure, average in-place density of 2.2 lbs. per cubic foot. Overall thickness shall be 4". Fire hazard classification according ASTM E-84 (UL 723) and is certified with UL label.

Metal Finishes:

- Exterior floor and ceiling shall be: 22 gauge galvanized – natural smooth steel.
- Exterior walls shall be: 26 gauge embossed white galvalume.
- Interior walls and ceiling shall be: 26 gauge embossed white galvalume.
- Interior floor shall be: 14-gauge smooth galvanized steel.

Panel Locking Assemblies: Assembly of walk-ins shall be accomplished by "Posi-Loc" locking assemblies, which shall be foamed-in-place and activated by a hex wrench provided by the manufacturer. Access ports shall be on interior to allow assembly of walk-in from the inside and shall be covered by snap caps.

Panel Gaskets: Flexible vinyl gaskets shall be foamed-in-place on the interior and exterior edge of the "tongue" rail. Gaskets shall be impervious to stains, greases, oils and mildew.

Entrance Door and Door Frame: Provide, where shown, 36" x 78" clear opening entrance door(s). The door shall be flush type, finished in and out, to match the wall in which it is located. Door and door section shall be listed by Underwriters Laboratories and equipped with the following: Magnetic gasket, "Posi-Seal" door closure, brushed chrome latch and strap-type, cam-lift hinges. Hardware shall have provisions for locking and a safety release to prevent entrapment of personnel within the box.

Door jamb and door perimeter shall be made of Fiberglass Reinforced Plastic. An isolated, low wattage heater wire covered by magnetically attracting stainless steel shall be fitted onto this jamb (freezer only). This shall provide perfect sealing of magnetic gasket and prevent frost and condensation buildup.

Each entrance door section shall be provided with an incandescent type vapor-proof light, pilot light switch and conduit between switch box and outlet box. Concealed wiring shall be standard on each entrance door section. (Note: See #14 for optional switches.)

When required, a threshold shall be provided with the door section. Heater wire shall continue beneath the threshold (freezer).

A 2" dial thermometer shall be included with each door section to indicate inside temperature.

Partitions: Fabrication and finish of partition walls shall be the same as the walk-in walls and shall lock into wall, ceiling, and floor panels (if used) with "Posi-Loc" locking assemblies (see Paragraph 7). Tongue and groove foam surfaces shall provide the thermal break between cooler and freezer compartments. Wall tee panels shall be 23" x 12" symmetrical tee.

NSF: All walk-ins shall be fabricated to comply with National Sanitation Foundation Standard No. 7. The NSF label shall be affixed to the interior door pan. Interior corners and floor shall be coved to meet NSF specifications.

Air Vent: A tri-action air vent shall be provided for freezers to equalize pressure between the interior and exterior of the walk-in caused by sudden temperature changes, due to door openings and evaporator defrosting. The vent shall be heated to prevent moisture and/or frost accumulation.

Installation Instructions: A complete set of installation instructions shall be included with the walk-in. These instructions shall cover the erection and assembly of the walk-in and the installation of refrigeration systems. A floor plan print shall be included.

ACCESSORIES

Each door shall be supplied with a View-Through Window: To provide vision in to the walk-in room, a 14" x 24" triple-pane window shall be used with a heated frame as standard. For freezer applications or humid conditions, heated glass shall be used. Window shall be neatly trimmed and designed for replacement in the field.

Kickplates: Each door shall be supplied with 0.080" aluminum diamond treadplate, kickplates on interior and exterior. Kickplate to be 36" high by width of door.

Alarm System: Furnish, as required, Modularm 1P-1 light control, panic, and auto panic inside compartment. Modularm MD-1 motion sensor. Modularm 75LC. The alarm shall record information during an alarm condition and display this information on command. The alarm shall have a mute switch to silence the audible alarm. It shall have a reset button to reset alarm once

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temperature conditions are satisfied. Built-in telephone jack accommodates remote alarm dialer or alarm system. Battery backup is provided.

Extra Vapor-Proof Lights: Provide (2) two (1 per compartment), additional ceiling mounted, vapor-proof lights. Exposed conduit on interior ceiling is not permitted.

Closure Panels: Furnish removable closure panels to enclose the area between the building and the walk-in ceilings. Panels to be fabricated of same material as walk-in exterior.

Strip Curtain for each door. Kason 36 x 78.

Tile and grout adder.

Center door section light over door.

14-Gauge stainless steel thresholds.

Trim Strips: Furnish trim strips between walk-in and building walls where shown. Constructed and finished of same material as exterior of walk-in.

Refrigeration Equipment:

Condensing unit shall be hermetic type, factory assembled and UL listed or recognized. Condenser shall be air-cooled. Components shall be mounted on a heavy gauge steel base.

Evaporator assembly shall be sized to balance with the condensing unit. It shall be made of plate type aluminum fins with copper tubes. Fan motors and coil to be housed in a heavy gauge aluminum enclosure. Evaporator shall have drain pan with suitable drainpipe fitting. Cooler evaporators to be air defrost. Freezer evaporators shall have an automatic electric defrost system including heaters, time clock, fan delay control and heated drain pan. Defrost shall be time initiated and temperature terminated with built-in fail-safe control.

System mounting shall be: "PR" Pre-Assembled Remote: A "PR" Pre-Assembled Remote refrigeration system shall consist of a condensing unit assembly, evaporator assembly and all necessary controls. On low temperature systems the time clock shall be shipped loose and is to be field located and wired. Refrigerant lines between condensing unit assembly and evaporator assembly shall be field supplied and installed.

Cooler System:

Evaporator Coil: AM26-70-1EC-PR-4KE2 (115/60/1)

Compressor: PC74MOP-3 (208-230/60/3) ¾-HP.

Freezer System:

Evaporator Coil: EL26-75-2EC-PR-4KE2 (208-230/60/1)

Compressor: PC199LOP-3 (208-230/60/3) 2-HP.

Refrigeration Accessories:

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Outdoor Package: (Note: Required for all air-cooled condensing units installed in an area where the temperature falls below 50 degree F. For ambient temperature below -20 degree F, consult factory.) The outdoor package shall include a crankcase heater, a control to maintain proper head pressure and weatherproof housing.

Condensing Unit Rack: Racks shall be constructed of heavy gauge angle iron which will be welded together and painted to resist rust. Racks shall be sized to accommodate condensing unit(s) specified.

Drain Lines: Furnished and installed by plumbing contractor, evaporators shall be provided with suitable drain lines. Drains shall be trapped outside the walk-in. Freezer drains shall be heated and insulated to prevent freeze-up. All plumbing to be in accordance with local codes.

Refrigeration Piping Installation: Furnish and install the interconnecting piping between the condensing unit and the respective unit coolers. Piping shall be installed in a neat and workmanlike manner with adjustable hangers spaced at no more than six (6) foot intervals on horizontal runs; and six (6) foot intervals on vertical runs.

Line sizes shall be in accordance with Copeland Handbook standards and best refrigeration practice, to assure: Proper feed to evaporator, Avoid excessive pressure drop, Prevent excessive amounts of lubricating oils from being trapped in any part of the system, Protect the compressor from loss of lubrication at all times, Prevent liquid refrigerant from entering the compressor during operating or idle time, To maintain a clean and dry system.

Refrigeration Piping shall be type "L" ACR grade, hard-drawn seamless copper tubing, Wrought type copper fittings, Silver-bearing soldered joints.

Condensate Drain shall be furnished and installed by plumbing contractor and shall consist of condensate drain piping from the unit cooler to open drain. Piping shall consist of: 7/8" type "L" copper tubing supported 36" on center maximum, in such a way that there will be 1" clearance between the wall and the tubing. Provide a union or slip fitting at the connection to the evaporator drain pan to allow easy disassembly for service and cleaning. Drain piping shall be "P-Trapped" on the exterior of the walk-in and adequately pitched thru the wall of the refrigerated area and discharged with-in 2" of a floor drain. Freezer drain line shall be wrapped with heat tape and insulated to prevent condensate freezing.

Piping Insulation: Suction line shall be covered with 1/2" thick Armaflex insulation, the insulation shall be applied to these lines in accordance with manufacturer's recommendations and, as they are being installed so that insulation will not be split. All joints shall be completely sealed with overlapping, cemented material to prevent the formation of frost on the lines. Penetrations shall be sealed with non-hardening caulking compound. The exposed ends of the penetration must be trimmed.

Refrigerant Testing: each system shall be triple-evacuated prior to charging. Fifteen hundred (1500) and Five Hundred (500) microns of vacuum shall be drawn successively and broken with dry refrigerant. After the third evacuation, the system shall be charged.

Guarantee: The equipment shall be guaranteed to maintain the specified temperatures. All mechanical refrigeration equipment shall be mechanically guaranteed for a period of one (1) year after date of acceptance of owner. The emergency service shall be provided free of charge, whenever necessary on a 24 hour, seven day-per-week basis. Any leaks that occur during the first year of operation after acceptance by the owner, shall be repaired and the necessary refrigerant added at no expense to the owner. The first years service shall be provided by the installing company and under no circumstances will the service be sublet to another refrigeration contractor. The name of the installer/service agency for the guarantee period shall be located in a highly visible place on the condensing unit. The compressor unit shall be provided with an

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additional four (4) year parts warranty to commence upon completion of the aforementioned guarantee, bringing the total warranty to five (5) years.

Item #: 39
Description: Evaporator Coil, Freezer
Manufacturer: Kolpak
Model #: EL26-75-2EC-PR-4KE2
SIS #: T037
Quantity: 1
Alternate Manufacturer: American Panel, Bally, Thermo-Kool

Specification:

As specified under Item # 39.

Item #: 40
Description: Compressor, Freezer
Manufacturer: Kolpak
Model #: PC199LOP-3
SIS #: T037
Quantity: 1
Alternate Manufacturer: American Panel, Bally, Thermo-Kool

Specification:

As specified under Item # 39.

Item #: 41
Description: Walk-In Cooler
Manufacturer: Kolpak
Model #: Custom
SIS #: T037
Quantity: 1
Alternate Manufacturer: American Panel, Bally, Thermo-Kool

Specification:

As specified under Item # 39.

Item #: 42
Description: Evaporator Coil, Cooler
Manufacturer: Kolpak
Model #: AM26-70-1EC-PR-4KE2
SIS #: T037
Quantity: 1
Alternate Manufacturer: American Panel, Bally, Thermo-Kool

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Specification:

As specified under Item # 39.

Item #: 43

Description: Compressor, Cooler

Manufacturer: Kolpak

Model #: PC74MOP-3

SIS #: T037

Quantity: 1

Alternate Manufacturer: American Panel, Bally, Thermo-Kool

Specification:

As specified under Item # 39.

Item #: 44

Description: Shelving Unit

Manufacturer: Cambro

Model #: Elements Series

SIS #: T037

Quantity: 10

Alternate Manufacturer: Metro

Specification:

Each unit to be a 4-Shelf Cambro Elements Series Starter Stationary Unit with the following features: Shelf Plates only with Camguard antimicrobial. 3 Post Heights 64", 72", 84". 3 Shelf Widths 18", 21", 24". 5 Shelf Lengths 36", 42", 48", 54", 60".

Each Starter Unit shall include: 4 stationary posts with leveling feet installed pre-assembled with post connectors and wedges, 1 bag of 32 stationary traverse dovetails (16 ea. A and B), Vented shelf plates (for 4 shelves), 8 stationary traverses and instructions.

Posts: Proprietary non-corrosive composite material. Post Connectors: Glass Filled Polypropylene. Traverses: Proprietary non-corrosive composite material. Vented/Solid Shelf Plates: Reinforced polypropylene with Camguard antimicrobial. Corner Connectors: Glass Filled Polypropylene. Adjustable Foot: Glass Filled Nylon. Seismic Foot: Stainless Steel post and wide foot plate, 3 holes for bolts. (Bolts not provided) Divider Bars: Glass Filled Nylon. Wall Fastener: Stainless Steel. Dovetails: Resin Nylon Wedges: Resin Polypropylene

- (2) Two units at 18" x 42" x 72" high. (model # ESU184272V4)
- (4) Four units at 18" x 48" x 72" high. (model # ESU184872V4)
- (4) Four units at 18" x 60" x 72" high. (model # ESU186072V4)

END OF SECTION

SECTION 115213 - PROJECTION SCREENS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Electrically operated, front-projection screens and controls.

- B. Related Requirements:

- 1. Section 055000 "Metal Fabrications" for metal support framing for front-projection screens.
 - 2. Section 115213.19 "Rear Projection Screens."

1.3 DEFINITIONS

- A. Gain: Ratio of light reflected from screen material to that reflected perpendicularly from a magnesium carbonate surface as determined per SMPTE RP 94.
- B. Half-Gain Angle: The angle, measured from the axis of the screen surface to the most central position on a perpendicular plane through the horizontal centerline of the screen where the gain is half of the peak gain.

1.4 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Product Data: For each type of product.
- C. Shop Drawings: Show layouts and types of front-projection screens. Include the following:
 - 1. Drop lengths.
 - 2. Location of seams in viewing surfaces.
 - 3. Location of screen centerline relative to ends of screen case.
 - 4. Anchorage details, including connection to supporting structure for suspended units.
 - 5. Details of juncture of exposed surfaces with adjacent finishes.
 - 6. Location of wiring connections for electrically operated units.

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7. Wiring diagrams for electrically operated units.
8. Accessories.

D. Samples for Initial Selection: For finishes of surface-mounted screen cases.

1.5 CLOSEOUT SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Maintenance Data: For front-projection screens to include in maintenance manuals.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Environmental Limitations: Do not deliver or install front-projection screens until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.7 COORDINATION

- A. Coordinate layout and installation of front-projection screens with adjacent construction, including ceiling suspension systems, light fixtures, HVAC equipment, fire-suppression system, and partitions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations for Projection Screens: Obtain each type of front-projection screen from single manufacturer. Obtain accessories, including necessary mounting hardware, from screen manufacturer.

2.2 ELECTRICALLY OPERATED, FRONT-PROJECTION SCREENS

- A. General: Manufacturer's standard units consisting of case, screen, motor, controls, mounting accessories, and other components necessary for a complete installation. Provide units that are listed and labeled as an assembly by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
 1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Controls: Remote, three-position control switch installed in recessed device box with flush cover plate matching other electrical device cover plates in room where switch is installed.
 - a. Provide two control switches for each screen.
 - b. Provide power supply for low-voltage systems if required.
 - c. Provide infrared remote control consisting of battery-powered transmitter and receiver.
 3. Motor in Roller: Instant-reversing motor of size and capacity recommended by screen manufacturer; with permanently lubricated ball bearings, automatic thermal-overload protection, preset limit switches to automatically stop screen in up and down positions, and positive-stop action to prevent coasting. Mount motor inside roller with vibration isolators to reduce noise transmission.
 4. Screen Mounting: Top edge securely anchored to rigid metal roller and bottom edge formed into a pocket holding a 3/8-inch- diameter metal rod with ends of rod protected by plastic caps.
 - a. Roller for end-mounted motor is supported by self-aligning bearings in brackets.
 - b. Roller for motor in roller is supported by vibration- and noise-absorbing supports.
 5. Tab Tensioning: Provide units that have a durable low-stretch cord, such as braided polyester, on each side of screen that is connected to edge of screen by tabs to pull screen flat horizontally.
- B. Suspended, Electrically Operated Screens with Automatic Ceiling Closure, with Motor-in Roller, and with Tab Tensioning: Units designed and fabricated for suspended mounting; with bottom of case composed of two panels, fully enclosing screen, motor, and wiring; one panel hinged and designed to open and close automatically when screen is lowered and fully raised, the other removable or openable for access to interior of case.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Da-Lite Screen Company.
 - b. Stewart Filmscreen Corporation.
 - c. Draper Manufacturing, Inc.
 2. Provide metal or metal-lined wiring compartment.
 3. Screen Case: Made from metal.
 4. Provide screen case with trim flange to receive ceiling finish.
 5. Finish on Exposed Surfaces: Vinyl covering or baked enamel.

2.3 FRONT-PROJECTION SCREEN MATERIAL

- A. Matte-White Viewing Surface: Peak gain of not less than 0.9, and gain of not less than 0.8 at an angle of 50 degrees from the axis of the screen surface.

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1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [BEI Audio-Visual Products.](#)
 - b. [Bretford, Inc.](#)
 - c. [Da-Lite Screen Company.](#)
 - d. [Draper Inc.](#)
 - e. [Stewart Filmscreen Corporation.](#)
- B. **Material:** Vinyl-coated, glass-fiber fabric.
- C. **Mildew-Resistance Rating:** Zero or 1 when tested according to ASTM G 21.
- D. **Flame Resistance:** Passes NFPA 701.
- E. **Flame-Spread Index:** Not greater than 75 when tested according to ASTM E 84.
- F. **Seamless Construction:** Provide screens, in sizes indicated, without seams.
- G. **Edge Treatment:** Without black masking borders.
- H. **Size of Viewing Surface:** 72 by 96 inches.
- I. **Provide extra drop length of dimensions and at locations indicated.**
 1. **Color:** Same as viewing surface.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install front-projection screens at locations indicated to comply with screen manufacturer's written instructions.
- B. Install front-projection screens with screen cases in position and in relation to adjoining construction indicated. Securely anchor to supporting substrate in a manner that produces a smoothly operating screen with vertical edges plumb and viewing surface flat when screen is lowered.
 1. Install low-voltage controls according to NFPA 70 and complying with manufacturer's written instructions.
 - a. **Wiring Method:** Install wiring in raceway except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Use UL-listed plenum cable in environmental air spaces, including plenum ceilings. Conceal raceway and cables except in unfinished spaces.

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2. Test electrically operated units to verify that screen controls, limit switches, closures, and other operating components are in optimum functioning condition.
3. Test manually operated units to verify that screen-operating components are in optimum functioning condition.

3.2 FRONT-PROJECTION SCREEN SCHEDULE

- A. Electrically Operated, Front-Projection Screen Type PS-1: Suspended, with automatic ceiling closure.
 1. Motor Configuration: Motor in roller.
 2. Screen Surface: Glass beaded.
 3. Size of Viewing Surface: 72 by 96 inches.
 4. Extra Drop Length: As needed at top of screen for bottom of screen to be 36 inches above floor.

END OF SECTION

SECTION 115213.19 - REAR PROJECTION SCREENS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Electrically operated, flexible rear-projection screens and controls.

- B. Related Requirements:

- 1. Section 055000 "Metal Fabrications" for metal support framing for rear-projection screens.
 - 2. Section 061053 "Miscellaneous Rough Carpentry" for wood backing for screen installation.

1.3 DEFINITIONS

- A. Gain: Ratio of light refracted by screen material to that reflected perpendicularly from a magnesium carbonate surface as determined per SMPTE RP 94, except that for measuring luminance of test screen, projection lamp shall be placed behind screen same distance as it was placed in front of magnesium carbonate surface for measuring luminance of reference standard.
- B. Half-Gain Angle: The angle, measured from the axis of the screen surface to the most central position on a perpendicular plane through the horizontal centerline of the screen where the gain is half of the peak gain.

1.4 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Product Data: For each type of product.
- C. Shop Drawings: Show layouts and types of rear-projection screens. Include the following:
 - 1. For rigid rear-projection screens:
 - a. Frame details.

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- b. Anchorage details.
 - c. Details of juncture of exposed surfaces with adjacent finishes.
 - d. Accessories.
2. For manually operated, flexible rear-projection screens:
- a. Drop lengths.
 - b. Anchorage details.
 - c. Accessories.
3. For electrically operated, flexible rear-projection screens and controls:
- a. Location of wiring connections for electrically operated units.
 - b. Drop lengths.
 - c. Anchorage details, including connection to supporting structure for suspended units.
 - d. Details of juncture of exposed surfaces with adjacent finishes.
 - e. Accessories.
 - f. Wiring diagrams.
- D. Samples for Initial Selection: For finishes of surface-mounted screen cases.

1.5 CLOSEOUT SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Maintenance Data: For rear-projection screens to include in maintenance manuals.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Environmental Limitations: Do not deliver or install rear-projection screens until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
- B. Store rear-projection screens in manufacturer's protective packaging and according to manufacturer's written instructions.

1.7 COORDINATION

- A. Coordinate layout and installation of rear-projection screens with adjacent construction, including ceiling suspension systems, light fixtures, HVAC equipment, fire-suppression system, and partitions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations for Rear-Projection Screens: Obtain each type of rear-projection screen from single manufacturer. Obtain accessories, including necessary mounting hardware, from screen manufacturer.
1. Obtain rear-projection screens from same manufacturer as front-projection screens.

2.2 ELECTRICALLY OPERATED, FLEXIBLE REAR-PROJECTION SCREENS

- A. General: Manufacturer's standard units consisting of case, screen, motor, controls, mounting accessories, and other components necessary for a complete installation. Provide units that are listed and labeled as an assembly by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Controls: Remote, three-position control switch installed in recessed device box with flush cover plate matching other electrical device cover plates in room where switch is installed.
 - a. Provide two control switches for each screen.
 - b. Provide power supply for low-voltage systems if required.
 - c. Provide infrared remote control consisting of battery-powered transmitter and receiver.
 - d. Provide video interface control for connecting to projector. Projector provides signal to raise or lower screen.
 3. Motor in Roller: Instant-reversing motor of size and capacity recommended by screen manufacturer; with permanently lubricated ball bearings, automatic thermal-overload protection, preset limit switches to automatically stop screen in up and down positions, and positive-stop action to prevent coasting. Mount motor inside roller with vibration isolators to reduce noise transmission.
 4. Screen Mounting: Top edge securely anchored to rigid metal roller and bottom edge formed into a pocket holding a 3/8-inch- diameter metal rod with ends of rod protected by plastic caps.
 - a. Roller is supported by vibration- and noise-absorbing supports.
 5. Tab Tensioning: Provide units that have a durable low-stretch cord, such as braided polyester, on each side of screen that is connected to edge of screen by tabs to pull screen flat horizontally.
- B. Suspended, Electrically Operated Screens with Automatic Ceiling Closure: Motor-in-roller units designed and fabricated for suspended mounting; with bottom of case composed of two panels,

fully enclosing screen, motor, and wiring; one panel is hinged and designed to open and close automatically when screen is lowered and fully raised, and the other is removable or openable for access to interior of case.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Da-Lite Screen Company.
 - b. Draper Inc.
 - c. Stewart Filmscreen Corporation.
2. Provide metal or metal-lined wiring compartment.
3. Screen Case: Made from metal.
4. Provide screen case constructed to be installed with underside flush with ceiling.
5. Finish on Exposed Surfaces: Vinyl covering or baked enamel.

2.3 FLEXIBLE REAR-PROJECTION SCREEN MATERIAL

- A. Ultra-Wide-Angle Screens: Coated vinyl sheet with peak gain of not less than 0.7, and half-gain angle of at least 70 degrees from the axis of the screen surface.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Da-Lite Screen Company.
 - b. Stewart Filmscreen Corporation.
 - c. Draper Manufacturing, Inc.
- B. Mildew-Resistance Rating: Zero or 1 when tested according to ASTM G 21.
- C. Flame Resistance: Passes NFPA 701.
- D. Flame-Spread Index: Not greater than 75 when tested according to ASTM E 84.
- E. Seamless Construction: Provide screens, in sizes indicated, without seams.
- F. Size of Viewing Surface: 120 by 120 inches.
- G. Provide extra drop length of dimensions and at locations indicated.
 1. Color: Same as viewing surface.

PART 3 - EXECUTION

3.1 FLEXIBLE REAR-PROJECTION SCREEN INSTALLATION

- A. Install rear-projection screens at locations indicated to comply with screen manufacturer's written instructions.
- B. Install rear-projection screens with screen cases in position and in relation to adjoining construction indicated. Securely anchor to supporting substrate in a manner that produces a smoothly operating screen with vertical edges plumb and viewing surface flat when screen is lowered.
 - 1. Install low-voltage controls according to NFPA 70 and complying with manufacturer's written instructions.
 - a. Wiring Method: Install wiring in raceway except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Use UL-listed plenum cable in environmental air spaces, including plenum ceilings. Conceal raceway and cables except in unfinished spaces.
 - 2. Test electrically operated units to verify that screen controls, limit switches, closures, and other operating components are in optimum functioning condition.
 - 3. Test manually operated units to verify that screen-operating components are in optimum functioning condition.

3.2 PROTECTING AND CLEANING RIGID REAR-PROJECTION SCREENS

- A. Provide temporary covering of rear-projection screens until time of Substantial Completion. Use type of covering approved by screen manufacturer that effectively protects screen from abrasion, breakage, or other damage.
- B. Clean rear-projection screens on both faces immediately before date scheduled for inspection intended to establish date of Substantial Completion. Use methods and cleaning materials recommended by screen manufacturer, taking care not to scratch or damage optical coatings or screen substrates.

3.3 REAR-PROJECTION SCREEN SCHEDULE

- A. Electrically Operated, Flexible Rear-Projection Screen Type PS-2: Suspended, with automatic ceiling closure.
 - 1. Screen Type: Wide angle.
 - 2. Size of Viewing Surface: 120 by 120 inches.
 - 3. Extra Drop Length: As needed at top of screen for bottom of screen to be 36 inches above floor.

END OF SECTION

SECTION 116143 - STAGE CURTAINS

PART I - GENERAL

1.1 RELATED DOCUMENT

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

1.2 WORK INCLUDED

- A. This section requires the fabrication, furnishing, delivery, and installation of the stage rigging systems, and all incidental or related items necessary to complete the work as described herein, even though they may not be specifically enumerated. The form of contract, general conditions, and the project drawings are considered to be parts of these specifications.
- B. The work of this section shall include, but not necessarily be limited to the following:
 - 1. Draperies
 - a. 1 - Grand Valance
 - b. 1 - Act Curtain - Track 2 sections
 - c. 1 - Cyc

1.3 GENERAL REQUIREMENTS

- A. Competence: The stage draperies and rigging contractor must have been engaged in the installation of stage rigging equipment for a minimum of ten years. As evidence of this experience and ability, the stage draperies contractor shall provide the following items:
 - 1. A listing of five or more completed jobs of similar or larger scope together with name, address and telephone number of Architect and Owner shall be part of the submittal.
 - 2. A brief written description of Contractor's operation including facilities, financial capabilities, and a description of key personnel shall be part of the submittal.
- B. Variation: While the components, units, and arrangements described herein and shown on the drawings indicate specific details for the realization of the stage systems, bidders may propose alternate details and components which will fulfill the functional parameters of the envisioned system. In such event, bidders shall follow the General Conditions.
- C. Intent: The stage draperies contractor shall furnish and provide all items, articles, equipment, materials, and operations listed, mentioned or scheduled in the drawings, and herein specified, including all tools, scaffolding, labor, transportation, insurance, services, supervision, and incidentals necessary and required for their completion of this project in a manner necessary for the proper execution of the work. Any errors, omissions or ambiguities are not to condition this requirement, but shall be brought to the attention of the Architect for their possible effect on the intent of the specifications.

- D. Safety: The systems shall conform to all applicable code requirements and shall be in conformance with industry standards of operation and practices. All materials, arrangements, and procedures shall comply with applicable OSHA requirements, allowing the users to arrange and operate a safe assembly and working environment for audience and user personnel.
- E. Delivery, Storage and Handling: The stage draperies contractor shall be responsible for storage of stage equipment tools and equipment during the period of the installation.
- F. Clean Up: The Contractor shall be responsible for clean up, including removal of packing materials etc. and the protection of surfaces or equipment provided by other contractors.
- G. All bidders shall fully inform themselves of the conditions under which the work is to be performed. No additional compensation shall be allowed for any matter or thing the bidder could have been fully informed of prior to the bid date.

1.4 APPLICABLE PUBLICATIONS & SPECIFICATIONS

- A. Quality Assurance: The following specifications and standards, except as hereinafter modified, are incorporated herein by reference and form a part of this specification to the extent indicated by the references thereto. Except where a specific date is given, the issue in effect (including amendments, addenda, revisions, supplements and errata) on the date of Invitation for Bids shall be applicable. In text such specifications and standards are referred to by the basic designation only.
- B. Materials: Materials shall conform to the following ASTM standard specifications:
 - 1. A-36 - Specification for structural steel
 - 2. A-47 - Specification for malleable iron casting
 - 3. A-48 - Specification for gray iron casting
 - 4. A-120 - Specification for black and hot-dipped zinc-coated (galvanized) steel pipe for ordinary use.
- C. Shop and field welding shall meet qualifications of A.I.S.C. manual and shall be without spatter or other evidence of poor practices.
- D. Publications: Publications listed below shall form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.
 - 1. Underwriters Laboratories, Inc (UL) Publication: UL 214-1976, Flame Test of Flame Propagation of Fabrics & Films.
 - 2. National Fire Protection Association (NFPA) Publication: NFPA No. 701 Flame-Resistant Textile, Films, Standard Method of Fire Test for, 1989 NFPA No. 101, Life Safety Code 1991.
 - 3. Wire Rope Technical Bulletin 3rd Edition.

All fabrics shall meet the most current statutory requirements of the State of Maine.

The manufacturer's named are to set a standard of quality substitutions are allowed providing the product is an equal or better quality than that which is referenced. Any changes shall be noted in the stage draperies contractor's bid.

1.5 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Shop Drawings: Submit shop and installation drawings and schedules showing all information necessary to explain fully the design features, appearance, function, fabrication, installation, and use of system components in all phases of operation. They shall be reviewed by the Architect before fabrication, installation or erection has begun. Such approval does not relieve the Stage Draperies Contractor of the responsibility of providing equipment in accordance with the specifications. Any deviations from the specifications shall be "starred" and noted in 1/4-inch high letters. Only deviations, which upgrade the quality of the equipment or respond to field conditions will be considered. Submittals shall include material and methods of attachment of specified Unistrut, slotted channel.
- C. Schedule: Prior to the commencement of the installation work, the Stage Draperies Contractor shall submit for approval an outline of a proposed schedule and requirements.
- D. Samples for Initial Selection:
 - 1. Rigging: The stage draperies contractor shall submit samples without causing delay in work, as required by the Owner's representative and as listed, but not necessarily limited to those specified below.
 - 2. Draperies: Fabric samples: Two each material proposed for use, in the quality, pattern, and color specified for review. Prior to delivery of material to the site, label samples for identification. Certified Laboratory Test Reports: Certified copies of reports of tests specified herein for flame resistance. 1 copy shall be posted on the stage as directed by Architect. Certificate shall be placed behind a clear polycarbonate panel mounted to the wall.
- E. Catalog Cuts: In lieu of drawings, the Contractor may wish to submit catalog cuts for certain standard equipment items. These must contain full information on dimensions, construction, applications, etc. to permit proper evaluation. In addition, they must be properly identified as to their intended use and any options or variations must be clearly noted.

1.6 CLOSEOUT SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Instructions: Upon completion of the work, the stage draperies contractor shall submit 3 copies of a detailed Operating and Maintenance Manual including as-built shop drawings, equipment descriptions, and parts lists. The Stage Draperies shall go through the manual with Owner-designated personnel to demonstrate and explain the maintenance and operation of the systems.

1.7 QUALITY ASSURANCE

- A. **Warranty:** The stage draperies contractor shall provide a one year written guarantee against defects in materials or labor starting from the date of acceptance of equipment by the Owner's representative. The warranty shall include routine maintenance on all materials, but shall not include normal wear and tear, damage due to neglect, or improper use of equipment. Any required maintenance or replacement shall be provided by the stage draperies contractor within thirty days of notification by the Owner except for safety related items, which shall be corrected within 48 hours of notification. Subsequent to the expiration of the warranty period the Stage Draperies Contractor agrees to furnish repair and maintenance service, at the Owner's expense, within 30 days of request for such service.
- B. **Final Dimensions:** Rough dimensions shall be used during the submittal process. Final dimensions for fabrication shall be done when accurate field dimensions can be obtained by this contractor after all interior finishes have been completed.
- C. **Stage draperies contractors** shall submit a written statement from the manufacturer attesting to their being an authorized dealer/distributor for the major equipment specified herein. If the bidder is acquiring any of the major equipment from another dealer, a written explanation shall be supplied on how factory authorized service would be supplied to Vinalhaven K-12.

1.8 INSPECTION AND TESTING

- A. **Inspection:** During the installation of equipment, the stage draperies contractor shall arrange for access as necessary for inspection of equipment by the Owner's representatives.
- B. **Special Testing:** If specifications, the Architect's instructions, laws, ordinances, or any public authority require any work to be specially tested or approved, the stage draperies contractor shall give the Architect timely notice of its readiness for inspection and of dates of inspections to be made by other authorities.
- C. **Completion Testing:** Upon completing the installation of all work specified under this section, the Contractor shall so notify the Architect, who will schedule an inspection. At the time of this inspection, the stage draperies contractor shall furnish sufficient workers to operate all equipment and to perform such adjustments and tests as may be required by the Owner's representative. Any equipment, which fails to meet with the specifications, shall be repaired or replaced with suitable equipment and the inspection shall be rescheduled under the same conditions as previously specified. At the time of these inspections, no other work shall be performed in the auditorium and stage areas. All temporary bracing, scaffolding, etc. shall be removed to permit full operation of and access to all equipment. Final approval will be withheld until all systems have been thoroughly tested and found to be in first class operating condition in every particular.

1.9

NOMENCLATURE

- A. The General Contractor and all sub-contractors performing work in the auditorium and supporting areas shall make themselves familiar with theatrical terminology as pertaining to these specifications. Interpretation of terms shall be as per the theatre consultant.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Rigging System

1. General

a. Finish:

- (1) Paint as required under this section shall be the manufacturer's standard finish and color except as noted.
- (2) All turnbuckles, clips, tracks, chains and other items of incidental hardware shall be furnished plated or painted.
- (3) All finishes which are disturbed during shipping and installation shall be touched up to match the original.

- b. All materials used in this project shall be new, unused and of the latest design. Re-furnished materials are not permitted.
- c. Where dimensions and loading capacities have been omitted from this specification, they are to be determined by the bidder in accordance with accepted industry standards and the guidelines in this section. In no way shall the stage draperies contractor be relieved of the primary responsibility to provide a safe, fully functional system.
- d. The mechanical fabrication and workmanship shall incorporate best practices for good fit and finish. There shall not be any burrs or sharp edges to cause a hazard nor shall there be any sharp corners accessible to personnel.

2. Pipe Battens & Suspension

- a. Description: All battens shall be 1-1/2-inch I.D., 1.900-inch nominal exterior diameter schedule 40 black steel pipe in lengths as scheduled. All joints shall be sleeve spliced with 18-inch long sleeves with 9-inches extending into each pipe and held by two 3/8-inch hex bolts and lock nuts on each side of the joint. There shall be as few joints as possible based on standard pipe lengths. Ends shall be free of burrs and all sharp edges removed inside and out. Supply and install Kee Klamp #77-8 plugs at each end.
- b. Suspension: All dead hung drapes and tracks shall be suspended from Uni-strut slotted angle above the stage. Provide and install a 1/4-inch proof coil chain (1300 lbs. working load) shall be used to suspend dead hung equipment from each slotted channel about 5'-0" on center. The end of the chain shall be connected with a 1/4-inch rapid link connector (1250 lb. working load). The load end of the chain shall be attached to a Jaw-Jaw 3/8 x 6 turnbuckle (1200 lb. working load) to allow for adjustment in the field. The turnbuckle

shall then be attached to the Clancy pipe mounting clamps or the Hanging clamps supplied with the tracks on the Act Curtain, and the three tracks for the roto-arms/legs.

1 - Grand Valance	Dead Hung
1 - Act Curtain - Track	Dead Hung
1 - Cyc	Dead Hung

- c. Material: Supply J.R. Clancy pipe batten #67-(length) and Pipe Clamps as per the following schedule:

	<u>Quantity</u>	<u>Length</u>	<u>Pipe Clamps</u>
Grand Valance	1	40'-0"	9- 26-22 x 1.5
Cyc	1	44'-0"	9 - 26-22 x 1.5

3. Draperies

- a. Curtains: To consist of the following items:

- 1 - Grand Valance
- 1 - Act Curtain - Track 2 sections
- 1 - Cyc

2. Grand Valance (1):

- a. Description: To be approximately 3'-0" high by 40'-0" wide. Grand Valance shall be box pleated on 12-inch centers in 50 percent fullness. Top hem to be reinforced with 3 1/2-inch jute webbing with through brass spur grommet at each pleat. Bottom hem to be turned back 3-inches. Suspension shall be to batten overhead by #4 cotton cord tie lines. Batten to be suspended using 1/4-inch proof coil chain, turnbuckles for adjustment as described in paragraph 2.01-A-2- b. Pleats shall be arranged to conceal seams.
- b. Material: Valances shall be fabricated from fire Stage retardant 25 oz./yd. 100 percent cotton velvet velour as manufactured by Rose Brand Textile Fabrics or Valley Forge Fabrics or KM Fabrics. Color shall be selected at time of submittals. Color to match act curtain. Nap direction shall be down. Trim height off floor shall be 13'-0" above finished floor.

3. Act Curtain (1):

- a. Description: Shall be of the traverse type split in the middle with each section to be approximately 15'-0" high by 24'-0" wide. Act curtain shall be box pleated on 12inch centers to 50 percent fullness. Top hems to be reinforced with 3-1/2-inch jute webbing with through brass spur grommet at each pleat. Bottom hem shall be weighted with No. 8 cadmium plated jack chain, in linen tube inside hem pocket. Center hems to be "faced back" 12-inches. Side hems to have 4-inch return. Suspension of the act curtain to the track carriers shall be by curtain snap hook ADC model #CCF-2 and TC-1 sufficient to hold weight of the curtains. Act curtains shall be lined.

- b. Material: Act curtains shall be fabricated from fire retardant 25 oz./yd 100 percent cotton velvet velour as manufactured by Rose Brand Textile Fabrics or Valley Forge Fabrics, or KM Fabrics. Color shall be selected at time of submittals. Color to match Grand Valance. Nap direction shall be down.
 - c. Description: Curtain track shall be 48'-0" long and be of 14 gauge galvanized steel construction entirely enclosed except for slot in bottom, each half to be 24'-0" in one continuous piece. Each curtain carrier shall be spaced on 12-inch centers and shall be of nylon construction supported from a ball-bearing by two polyethylene wheels held to ball-bearing by rust-proof nickel plated rivet, such wheels rolling on two separate parallel treads. Each curtain carrier shall consist of a free moving plated swivel and sufficient trim chain to accommodate curtain snap hook ADC model #CCF-2. End pulley blocks shall be adjustable and shall be equipped with sleeve-bearing wheels adequately guarded. A rubber bumper shall be attached to each curtain carrier to function as noise reducer. The manufacturer shall furnish two end stops for placement at each track end and a tension floor pulley for increasing or decreasing cord tension. Stretch-resistant operating cord shall have fiberglass center and shall be of 3/8-inch diameter, extra quality yarn. Floor pulley for operating line shall be located stage left. Track shall be dead hung from trusses or slotted channel, every 5'-0" (13 brackets total). The track shall be supplied with ADC #2808 hanging clamps (#2807 Lap Clamp at center stage) enabling the track to be suspended from the Trusses by 1/4-inch proof coil chain and turnbuckles to allow for field adjustment as described in paragraph 2.01-A-2-b. Mount the Act curtain track centerline between track overlap 1'-6" upstage of the plaster line.
 - c. Equipment: Model #280-A CWANA as manufactured by ADC (Automatic Devices Company) of Allentown, PA.
4. Cyc (1):
- a. Description: To consist of one (1) piece: To be approximately 19'-0" high by 44'-0" wide. Backdrop shall be a flat fabric surface with no seams. Top hems to be reinforced with 3-1/2-inch jute webbing with through brass spur grommet 12-inches on center. Bottom hems shall be weighted with pipe, in linen tube inside hem pocket. Side hems to have 12-inch returns. Suspension of the backdrop shall be to the furthest upstage pipe batten overhead by #4 cotton cord tie lines. Batten to be suspended from Trusses using 1/4-inch proof coil chain and turnbuckles for adjustment as described in paragraph 2.01-A-2-b. Batten shall be hung straight and parallel to the stage floor.
 - b. Material: Cyc shall be fabricated from seamed natural muslin fire retarded as Manufactured by Valley Forge Fabrics or Rose Brand Fabrics. Color shall be natural.

PART 3 - EXECUTION

3.1 RIGGING

- A. Stage draperies contractor shall utilize equipment that is sufficient to handle the loads placed upon the draperies and the trusses. Mounting height as scheduled.

3.2 DRAPERIES

- A. Delivery and Storage: Deliver draperies and hardware to the site in sealed containers clearly labeled as to manufacturer's name and contents. Store in a safe, dry, clean, and well-ventilated area. Do not open containers until needed for installation, unless verification inspection is required.
- B. Installation: Install stage curtains after the work of other trades and cleaning operations are completed. Dead hang the grand valance and act curtain/track directly upstage of proscenium arch plaster line. Borders, legs, and cyc shall be hung per instructions of the Architect and/or theatre consultant. Include all materials indicated, specified, and/or necessary for a complete finished installation. Final trim height adjustments for the draperies shall be done in the field. The objective is to allow a maximum on stage vertical height while providing complete masking of the area above the stage from view from patrons sitting in the first row of seats. Side masking shall be per dimensions given in this project manual. Theatrical contractor shall be responsible for the required quantities of fabric and hardware, and shall carefully check dimensions in the field as well as other condition affecting the work. Install hardware in accordance with the manufacturer's printed instructions. Adjustments shall be made to the operating features to assure a smooth operation.
- C. All draperies are to be hung straight. Bottom edges of all draperies shall be parallel to the finished stage floor. Act curtain, and legs shall be no less than 1-inch or no more than 1-1/2-inches above the finished floor. Borders and the grand valance shall be trimmed as scheduled above finished floor. Any adjustments to these specifications shall not be instituted unless authorized by the Architect. Finished height of all draperies shall be confirmed in the field before submittal and fabrication. All equipment under this contract shall be hung utilizing equipment that is sufficient to handle the loads placed upon them. Install stage curtains in the proper locations indicated on the drawings. Include all materials indicated, specified, and/or necessary for a complete finished installation.

3.3 CLEANING AND PROTECTION

- A. Clean rigging and drapery surfaces after installation, according to manufacturer's written instructions.
- B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that rigging and drapery are without damage or deterioration at time of Substantial Completion.
- C. Replace damaged rigging and drapery that cannot be repaired, in a manner approved by Architect, before time of Substantial Completion.

3.4

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DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain rigging and drapery.

END OF SECTION

SECTION 116623 - GYMNASIUM EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Basketball equipment.
2. Volleyball equipment.
3. Safety pads.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for oversized recessed voids to be cast in concrete slabs and footings.
2. Section 096566 "Resilient Athletic Flooring" for game lines and markers.

1.3 DEFINITIONS

- A. FIBA: Federation Internationale de Basketball Amateur (The International Basketball Federation).
- B. FIVB: Federation Internationale de Volleyball (The International Volleyball Federation).
- C. NCAA: The National Collegiate Athletic Association.
- D. NFHS: National Federation of State High School Associations.
- E. USAV: USA Volleyball.

1.4 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Product Data: For each type of product.
 1. If applicable, include assembly, disassembly, and storage instructions for removable equipment.

2. Motors: Show nameplate data, ratings, characteristics, and mounting arrangements.
- C. Sustainable Design Submittals:
1. **Product Data:** For composite wood products, indicating that product contains no urea formaldehyde.
 2. **Laboratory Test Reports:** For composite wood products, indicating compliance with requirements for low-emitting materials.
- D. Shop Drawings: For gymnasium equipment.
1. Include plans, elevations, sections, details, and attachments to other work.
 2. Include details of field assembly for removable equipment, connections, installation, mountings, floor inserts, attachments to other work, and operational clearances.
 3. Include transport and storage accessories for removable equipment.
- E. Samples: For each exposed product and for each item and color specified.
- F. Samples for Initial Selection: For each type of gymnasium equipment.
- G. Samples for Verification: For the following products:
1. Basketball Net: Full size.
 2. Volleyball Net: Minimum 12-inch length by full height, including one edge and net accessories.
 3. Volleyball Floor Insert: Full-size unit.
 4. Volleyball Post Standard: Full-size unit.
 5. Pad Fabric: Wall padding not less than 3 inches square, with specified treatments applied. Mark face of material.

1.5 INFORMATIONAL SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 “Submittal Procedures” and the individual sections specifying the work.
- B. Coordination Drawings: Court layout plans, drawn to scale, and coordinated with floor inserts, game lines, and markers applied to finished flooring.
- C. Qualification Data: For Installer.
- D. Product Certificates: For each type of gymnasium equipment.
- E. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 “Submittal Procedures” and the individual sections specifying the work.

- B. Operation and Maintenance Data: For gymnasium equipment to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

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

1.8 FIELD CONDITIONS

- A. Environmental Limitations: Do not install gymnasium equipment until spaces are enclosed and weatherproof, wet work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
- B. Field Measurements: Verify position and elevation of floor inserts and layout for gymnasium equipment.

1.9 COORDINATION

- A. Coordinate installation of floor inserts with structural floors and finish flooring installation and with court layout and game lines and markers on finish flooring.
- B. Coordinate layout and installation of overhead-supported gymnasium equipment and suspension-system components with other construction including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.

1.10 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of gymnasium equipment that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Basketball backboard failures including glass breakage.
 - b. Faulty operation of basketball backstops.
 - 2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS, GENERAL

- A. Source Limitations: Obtain each type of gymnasium equipment from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Basketball backstops and anchors shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

2.3 BASKETBALL EQUIPMENT

- A. Basis-of-Design Product: Subject to compliance with requirements, provide "090949000 – Forward Fold Backstop," Porter Athletic, or comparable product by one of the following:
1. AALCO Manufacturing.
 2. ADP Lemco.
 3. Arizona Courtlines, Inc.
 4. Basketball Products International.
 5. Bison, Inc.
 6. Douglas Industries, Inc.
 7. Draper Inc.
 8. IPI by Bison.
 9. Jaypro Sports, LLC.
 10. L. A. Steelcraft Products, Inc.
 11. P. W. Athletic Mfg. Co.
 12. Performance Sports Systems.
 13. Schelde North America.
 14. Spalding Equipment.
- B. General: Provide equipment complying with requirements in NCAA's "Men's and Women's Basketball Rules and NFHS's "NFHS Basketball Rules Book."
- C. Protruding fasteners or exposed bolt heads on front face of backboards are not permitted.
- D. Provide manufacturer's recommended connections complying with Section 055000 "Metal Fabrications" of size and type required to transfer loads to building structure.
- E. Overhead-Supported Backstops:
1. Stationary Type: Manufacturer's standard assembly.
 2. Folding Type: Provide manufacturer's standard assembly for forward-folding, front-braced backstop, with hardware and fittings to permit folding.
 3. Framing: Steel pipe, tubing, and shapes. Design framing to minimize vibration during play.
 - a. Center-Mast Frame: Welded with side sway bracing.
 - b. Finish: Manufacturer's standard primer for field finishing.
 4. Goal Height Adjuster: Adjustable from 8 to 10 feet with gear-drive mechanism, locking in any position within adjustment range, with visible height scale attached to side of framing.

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- a. Operation: Electric with integral gear-drive motor, with limit switches preset to goal heights and the following:
 - 1) Key switch control.
- F. Backstop Safety Device: Designed to limit free fall if support cable, chains, pulleys, fittings, winch, or related components fail; with mechanical automatic reset; 6000-lb load capacity; one per folding backstop.
 1. Retractor Device: Manufacturer's standard device designed to retract both support and safety cables, chains, and straps away from play of the basketball when backstop is in playing position; one per folding backstop.
- G. Backstop Electric Operator: Provide operating machine of size and capacity recommended by manufacturer for equipment specified, with electric motor and factory-prewired motor controls, starter, gear-reduction unit, and remote controls. Coordinate wiring requirements and electrical characteristics with building electrical system.
 1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Operator Type: Cable drum with grooved drum and cable tension device to automatically take up cable slack and retain cable in grooves.
 3. Operator Mounting: Wall-mounted board.
 4. Motor Electrical Characteristics:
 - a. Voltage: NEMA standard voltage selected to operate on nominal circuit voltage to which motor is connected.
 - b. Horsepower: 1/2 hp.
 - c. Phase: Single.
 5. Remote-Control Station(s): NEMA ICS 6, Type 1 enclosure for recessed or flush mounting and momentary-contact, three-position, switch-operated control with up, down, and off functions.
 - a. Group Key Switch Control Stations: One switch per two backstops.
 - b. Keys: Provide one key per station.
 - c. Switches, Ganged: Single faceplate with multiple switch cut-outs for two switches operating four backstops.
 - d. Control Station Enclosure: Provide prime-painted metal enclosure with key access with two sets of keys per enclosure.
 6. Limit Switches: Adjustable switches, interlocked with motor controls and set to automatically stop basketball equipment at fully retracted and fully lowered positions.
- H. Basketball Backboards:
 1. Shape and Size:
 - a. Rectangular, 72 by 42 inches width by height.

2. Backboard Material: With predrilled holes or preset inserts for mounting goals, and as follows:
 - a. Fiberglass: Not less than 1-1/2-inch- thick, composite backboard consisting of not less than two 3/16-inch- thick, molded fiberglass panels laminated together over faces and edges encapsulating a 3/4-inch honeycomb core, reinforced at goal and backboard mountings, or a wood panel product core; with threaded inserts or embedded anchors for mounting backboard corners to support framing at standard mounting centers.
 - b. Glass: Not less than 1/2-inch- thick, transparent tempered glass complying with ASTM C 1048 Kind FT (fully tempered) and with impact testing requirements in 16 CFR 1201 Category II or ANSI Z97.1 Class A for safety glazing. Provide glass and framing system manufactured to comply with FIBA Level 1 or Level 2 requirement that glass does not split off if broken. Provide glass with impact-absorbing resilient rubber or PVC gasket around perimeter in a fully welded, painted steel frame, with steel subframe, reinforcement, bracing, and mounting slots for mounting backboard frame to backboard support framing.
 - 1) Rim-Restraining Device: Complying with NCAA and NFHS rules and designed to ensure that basket remains attached if glass backboard breaks.
 - c. Steel: Single-piece, steel face sheet, not less than 0.1046-inch nominal thickness, with 1-1/2-inch-deep, roll-edged perimeter flange and with steel-reinforced, welded frame welded to back side of backboard; with mounting slots for mounting backboard frame to backboard support framing at standard mounting centers.
3. Target Area and Border Markings (Glass): Permanently etched in white color, marked in pattern and stripe width according to referenced rules.
4. Target Area and Border Markings (Opaque): Marked in pattern, stripe width, and color according to referenced rules.
5. Finish: Manufacturer's standard factory-applied, white background.
- I. Goal Mounting Assembly: Compatible with goal, backboard, and support framing; with hole pattern that is manufacturer's standard for goal attachment.
 1. Glass Backboard Goal Mounting Assembly: Goal support framing and reinforcement designed to transmit load from goal to backboard frame and to minimize stresses on glass backboard.
 2. Direct Mount: Designed for mounting goal directly and independently to center mast of backboard support framing so no force, transmitted by ring, is directly applied to backboard, and rigidity and stability of goal are maximized.
- J. Basketball Goals: Complete with flanges, braces, attachment plate, and evenly spaced loops welded around underside of ring.
 1. Single-Rim Basket Ring Competition Goal: Materials, dimensions, and fabrication complying with referenced rules.
 2. Type: Movable, breakaway design with manufacturer's standard breakaway mechanism and rebound characteristics identical to those of fixed, nonmovable ring.

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3. Breakaway Characteristics: Positive-lock movable breakaway design, with manufacturer's standard breakaway mechanism including preset pressure release, set to release at 230-lb load, and automatic reset. Provide movable ring with rebound characteristics identical to those of fixed, nonmovable ring.
 4. Mount: Front.
 5. Net Attachment: No-tie loops for attaching net to rim without tying.
 6. Finish: Manufacturer's standard polyester powder-coat finish.
- K. Basketball Nets: 12-loop-mesh net, between 15 and 18 inches long, sized to fit rim diameter, and as follows:
1. Cord: Made from white nylon.
 2. Competition Cord: Antiwhip, made from white nylon cord not less than 120-gm thread and not more than 144-gm thread.
- L. Backboard Safety Pads: Designed for backboard thickness indicated and extending continuously along bottom and up sides of backboard and over goal mounting and backboard supports as required by referenced rules.
1. Attachment: Manufacturer's standard.
 2. Color: As selected by Architect from manufacturer's full range.

2.4 VOLLEYBALL EQUIPMENT

- A. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
1. [AALCO Manufacturing.](#)
 2. [ADP Lemco.](#)
 3. [Arizona Courtlines, Inc.](#)
 4. [Bison, Inc.](#)
 5. [Douglas Industries, Inc.](#)
 6. [Draper Inc.](#)
 7. [IPI by Bison.](#)
 8. [Jaypro Sports, LLC.](#)
 9. [L. A. Steelcraft Products, Inc.](#)
 10. [P. W. Athletic Mfg. Co.](#)
 11. [Performance Sports Systems.](#)
 12. [Porter Athletic Equipment Company.](#)
 13. [Schelde North America.](#)
 14. [Spalding Equipment.](#)
 15. [Sports Imports.](#)
- B. General: Provide equipment complying with requirements in NFHS's "NFHS Volleyball Rules Book."
- C. Floor Insert: Chrome-finished steel floor plate; and steel pipe sleeve, concealed by floor plate, with capped bottom end, sized with ID to fit post standards, not less than length required to

securely anchor pipe sleeve in structural floor; with anchors designed for securing floor insert to floor substrate indicated; one per post standard.

1. Floor Plate: Lockable, hinged access cover, designed to be flush with adjacent flooring. Provide two tool(s) for unlocking access covers.

2.5 SAFETY PADS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. [AALCO Manufacturing.](#)
2. [ADP Lemco.](#)
3. [American Athletic, Inc.](#)
4. [Bison, Inc.](#)
5. [Douglas Industries, Inc.](#)
6. [Draper Inc.](#)
7. [IPI by Bison.](#)
8. [Jaypro Sports, LLC.](#)
9. [Performance Sports Systems.](#)
10. [Porter Athletic Equipment Company.](#)
11. [Schelde North America.](#)
12. [Spalding Equipment.](#)

- B. Safety Pad Surface-Burning Characteristics: ASTM E 84 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 450 or less.

- C. Pad Coverings: Provide safety pad fabric covering that is fabricated from puncture- and tear-resistant, PVC-coated polyester or nylon-reinforced PVC fabric, not less than 14-oz./sq. yd and treated with fungicide for mildew resistance; with surface-burning characteristics indicated.

- D. Wall Safety Pads: Padded wall wainscot panels designed to be attached in a continuous row; each panel section consisting of fill laminated to backer board with visible surfaces fully covered by seamless fabric covering, free of sag and wrinkles and firmly attached to back of backer board.

1. Backer Board: Not less than 3/8-inch- thick plywood, mat formed, or composite panel.
2. Fill: Multiple-impact-resistant foam not less than 1-1/2-inch- thick polyurethane, 3.5-lb/cu. ft. density.
3. Size: Each panel section, manufacturer's standard dimensions.
4. Number of Modular Panel Sections: As indicated.
5. Installation Method: Manufacturer's standard.
6. Fabric Covering Color(s): As selected by Architect from manufacturer's full range for two color(s).
7. Graphics: Custom graphics as indicated.

- E. Corner Wall Safety Pads: Wall corner pad consisting of not less than 1-1/4-inch- thick, multiple-impact-resistant, closed-cell, polyethylene-foam filler, covered on both sides and all edges by fabric covering with backer board and manufacturer's standard anchorage to wall.
 - 1. Length: Each pad matching length of wall safety pads.
 - 2. Fabric Covering Color(s): Match color of wall safety pads.
- F. Column Safety Pads: Pads covering exposed flange of columns to height indicated, consisting of not less than 1-1/4-inch- thick, multiple-impact-resistant, closed-cell, polyethylene-foam filler, covered on both sides and all edges by fabric covering with backer board and manufacturer's standard anchorage to column.
 - 1. Length: Each pad matching length of wall safety pads.
 - 2. Fabric Covering Color(s): Match color of wall safety pads.
- G. Round Column Safety Pads: Wraparound pads fully covering exposed round column to height indicated, consisting of not less than 2-inch-thick, multiple-impact-resistant, bonded polyurethane-foam filler, 6.0-lb/cu. ft density, covered on both sides and all edges by fabric covering with hook-and-loop attachment to column.
 - 1. Length: Each pad matching length of wall safety pads.
 - 2. Fabric Covering Color(s): Match color of wall safety pads.
- H. Cut-out Trim: Provide manufacturer's standard flanged cut-out trim kits for fitting pads around switches, receptacles, and other obstructions.
 - 1. Color: As selected by Architect from manufacturer's full range.

2.6 MATERIALS

- A. Steel: Comply with the following:
 - 1. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
 - 2. Steel Tubing: ASTM A 500/A 500M or ASTM A 513, cold formed.
 - 3. Steel Sheet: ASTM A 1011/A 1011M.
- B. Support Cable: Manufacturer's standard galvanized-stranded-steel wire rope with a breaking strength of 7000 lb. Provide fittings complying with wire rope manufacturer's written instructions for size, number, and installation method.
- C. Castings and Hangers: Malleable iron, complying with ASTM A 47/A 47M; grade required for structural loading.
- D. Composite Wood Products: Products shall be made without urea formaldehyde.
- E. Composite Wood Products: Products 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."

- F. Softwood Plywood: DOC PS 1, exterior.
- G. Particleboard: ANSI A208.1.
- H. Equipment Wall-Mounted Board: Wood, neutral-color-painted finish, size, and quantity as required to mount gymnasium equipment according to manufacturer's written instructions.
- I. Anchors, Fasteners, Fittings, and Hardware: Manufacturer's standard corrosion-resistant or noncorrodible units; concealed; tamperproof, vandal- and theft-resistant design.
- J. Grout: Nonshrink, nonmetallic, premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout, complying with ASTM C 1107/C 1107 with minimum strength recommended in writing by gymnasium equipment manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for play court layout, alignment of mounting substrates, installation tolerances, operational clearances, accurate locations of connections to building electrical system, and other conditions affecting performance of the Work.
 - 1. Verify critical dimensions.
 - 2. Examine supporting structure, subgrades, subfloors, and footings below finished floor.
 - 3. Examine wall assemblies, where reinforced to receive anchors and fasteners, to verify that locations of concealed reinforcements are clearly marked. Locate reinforcements and mark locations.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. General: Comply with manufacturer's written installation instructions and competition rules indicated for each type of gymnasium equipment. Complete equipment field assembly where required.
- B. Unless otherwise indicated, install gymnasium equipment after other finishing operations, including painting, are completed.
- C. Permanently Placed Gymnasium Equipment and Components: Install rigid, level, plumb, square, and true; anchored securely to supporting structure; positioned at locations and elevations indicated; in proper relation to adjacent construction; and aligned with court layout.
 - 1. Floor Insert Location: Coordinate location with application of game lines and markers, and core drill floor for inserts after game lines are applied.

2. Floor Insert Elevation: Coordinate installed heights of floor insert with installation and field finishing of finish flooring and floor-plate type.
 3. Operating Gymnasium Equipment: Verify clearances for movable components of gymnasium equipment throughout entire range of operation and for access to operating components.
- D. Floor Insert Setting: Position sleeve in oversized, recessed voids in concrete slabs. Clean voids of debris. Fill void around sleeves with grout, mixed and placed to comply with grout manufacturer's written instructions. Protect portion of sleeve above subfloor from splatter. Verify that sleeves are set plumb, aligned, and at correct height and spacing; hold in position during placement and finishing operations until grout is sufficiently cured. Set insert so top surface of completed unit is flush with finished flooring surface.
- E. Wall, Corner and Column Safety Pads: Mount with bottom edge at 4 inches above finished floor.
- F. Cut-out Trim: Limit cuts in face of padding from trim unit's corner-to-corner outside dimensions. Install with ends of cuts concealed behind trim flange.
- G. Anchoring to In-Place Construction: Use anchors and fasteners where necessary to secure built-in and permanently placed gymnasium equipment to structural support and to properly transfer load to in-place construction.
- H. Connections: Connect electric operators to building electrical system.
- I. Removable Gymnasium Equipment and Components: Assemble in place to verify that equipment and components are complete and in proper working order. Instruct Owner's designated personnel in properly handling, assembling, adjusting, disassembling, transporting, storing, and maintaining units. Disassemble removable gymnasium equipment after assembled configuration is approved by Owner, and store units in location indicated on Drawings.

3.3 ADJUSTING

- A. Adjust movable components of gymnasium equipment to operate safely, smoothly, easily, and quietly, free from binding, warp, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Lubricate hardware and moving parts.

3.4 CLEANING

- A. After completing gymnasium equipment installation, inspect components. Remove spots, dirt, and debris and touch up damaged shop-applied finishes according to manufacturer's written instructions.
- B. Replace gymnasium equipment and finishes that cannot be cleaned and repaired, in a manner approved by Architect, before time of Substantial Completion.

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3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain gymnasium equipment.

END OF SECTION

SECTION 116800 - PLAY FIELD EQUIPMENT AND STRUCTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes playground equipment as follows:
 - 1. Freestanding playground equipment.

1.3 DEFINITIONS

- A. Definitions in ASTM F 1487 apply to Work of this Section.
- B. IPEMA: International Play Equipment Manufacturers Association.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Product Data: For each type of product.
- C. Shop Drawings: For each type of playground equipment.
 - 1. Include plans, elevations, sections, and attachment details.
 - 2. Include fall heights and use zones for playground equipment, coordinated with the critical-height values of protective surfacing specified in Section 321816.13 "Playground Protective Surfacing."
- D. Samples for Initial Selection: For each type of exposed finish.
 - 1. Manufacturer's color charts.
 - 2. Include Samples of accessories involving color selection.

1.6 INFORMATIONAL SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 “Submittal Procedures” and the individual sections specifying the work.
- B. Qualification Data: For Installer, manufacturer and testing agency.
- C. Product Certificates: For each type of playground equipment.
- D. Field quality-control reports.
- E. Sample Warranty: For manufacturer's special warranties.

1.7 CLOSEOUT SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 “Submittal Procedures” and the individual sections specifying the work.
- B. Maintenance Data: For playground equipment and finishes to include in maintenance manuals.

1.8 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A firm whose playground equipment components have been certified by IPEMA's third-party product certification service.
- B. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.9 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of playground equipment that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures.
 - b. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.
 - 2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufactured playground equipment and components shall have the IPEMA Certification Seal.

2.2 PERFORMANCE REQUIREMENTS

- A. Safety Standard: Provide playground equipment according to ASTM F 1487.

2.3 FREESTANDING PLAYGROUND EQUIPMENT

- A. Classic Swing Set: Traditional style with tripod angled legs providing upright support.

1. Basis-of-Design Product: Subject to compliance with requirements, provide “Classic Swing” by GameTime, or comparable product by one of the following:
 - a. Landscape Structures Inc.
 - b. Miracle Recreation Equipment Co.; a division of PlayPower, Inc.
2. Metal Frame: Galvanized-steel pipe or tubing.
 - a. Leg Upright(s): Not less than 2-3/8-inch OD.
 - b. Overhead Beam: Not less than 2-3/8-inch OD.
 - c. Color: As selected by Architect from manufacturer's full range.
3. Overhead Beam Height: 96 inches from pivot point to protective surfacing below.
4. Suspension Members: Manufacturer's standard.
 - a. Color: As indicated by manufacturer's designations.
5. Swing Connector: Double clevis and bolt link.
6. Swing Hanger: Galvanized manufacturer's standard.
7. Swing Seats: U-shaped flexible belt seat made from rubber or plastic.
 - a. Color: As selected by Architect from manufacturer's full range.
 - b. Basis-of-Design: Adaptive Swing Seat “Zero-G Swing Chair – 5-12” by GameTime, or approved equal by:
 - 1) Landscape Structures Inc.
 - 2) Miracle Recreation Equipment Co.; a division of PlayPower, Inc.
8. Capacity: Seven belt swings and one adaptive swing (8 total).
9. Age Appropriateness: Five through 12 years.

- B. Disc Swing: Contemporary style arch frame with cable-suspended disc swing.

1. Basis of Design Product: “Arch Swing” by GameTime or comparable product by one of the following:
 - a. Dynamo Playgrounds
 - b. Landscape Structures Inc.
 - c. Miracle Recreation Equipment Co.; a division of PlayPower, Inc.
2. Color: As selected by Architect from manufacturer’s full range.

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3. Age appropriateness: Two through five years and five through 12 years.
- C. Six-Foot Deck Hill Slide: Double-diverging descending chute(s).
1. Basis-of-Design Product: Subject to compliance with requirements, provide "6'-0" Hillside Dueling Wave Zip Slide" by GameTime, or comparable product by one of the following:
 - a. Landscape Structures Inc.
 - b. Miracle Recreation Equipment Co.; a division of PlayPower, Inc.
 2. Colors: As selected by Architect from manufacturer's full range.
 3. Age Appropriateness: Five through 12 years.
- D. Five Foot Deck Hill Slide: Single descending chute.
1. Basis-of-Design Product: Subject to compliance with requirements, provide "5'-0" Hillside Zip Slide" by GameTime, or comparable product by one of the following:
 - a. Landscape Structures Inc.
 - b. Miracle Recreation Equipment Co.; a division of PlayPower, Inc.
 2. Colors: As selected by Architect from manufacturer's full range.
 3. Age Appropriateness: Five through 12 years.
- E. Three Foot Deck Hill Slide: Single descending chute.
1. Basis-of-Design Product: Subject to compliance with requirements, provide 3'-0" Wave Zip Slide by GameTime, or comparable product by one of the following:
 - a. Landscape Structures Inc.
 - b. Miracle Recreation Equipment Co.; a division of PlayPower, Inc.
 2. Colors: As selected by Architect from manufacturer's full range.
 3. Age Appropriateness: Five through 12 years.
- F. Tunnel (Crawl Tube): Freestanding, straight-aligned configuration.
1. Material: Precast concrete catch basin barrel sections, ASTM C 478, ID not less than 36 inches.
 2. Color: Natural.
- G. Net Climber: Flexible cable net.
1. Basis-of-Design Product: Subject to compliance with requirements, provide "High Stepper Large" by GameTime, or comparable product by one of the following:
 - a. Dynamo Playground.
 - b. Landscape Structures Inc.
 - c. Miracle Recreation Equipment Co.; a division of PlayPower, Inc.

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2. Colors: As selected by Architect from manufacturer's full range.
3. Age Appropriateness: Five through 12 years.

H. Monkey Bar Structure:

1. Basis-of-Design Product: Subject to compliance with requirements, provide “Small Muscle Man Climber” by GameTime, or comparable product by one of the following:
 - a. Landscape Structures Inc.
 - b. Miracle Recreation Equipment Co.; a division of PlayPower, Inc.
2. Colors: As selected by Architect from manufacturer's full range.
3. Age Appropriateness: Five through 12 years.

I. Arch Bridge:

1. Basis-of-Design Product: Subject to compliance with requirements, provide “Arch Bridge with Barrier: 3 Deck Span” by GameTime, or comparable product by one of the following:
 - a. Landscape Structures Inc.
 - b. Miracle Recreation Equipment Co.; a division of PlayPower, Inc.
2. Colors: As selected by Architect from manufacturer's full range.
3. Age Appropriateness: Five through 12 years.

J. Basketball Goal: Gooseneck style, galvanized steel pipe post with metal backboard:

1. Post: 4-1/2 inch OD RS40 flow coated galvanized steel tubing with a 7 gauge wall thickness. Design shall be a bent gooseneck style and allow for a minimum 4'-0" burial in ground and 4'-0" extension from the front of the post to the face of the backboard. Post shall be designed such that the rim mounts directly to the horizontal post section through the backboard. Pole systems without backboard support braces shall not be considered equal.
2. Backboard: Fan-shaped 35-1/2" x 54" aluminum backboard with heavy support ribs, white powder coated finish, and orange shooter's square and border.
3. Rim: Shall consist of two 5/8" diameter AISI 1018 cold drawn carbon steel rings welded together at a minimum of six places. Back and side plates shall be 3/16" thick and be continuously welded. The net attachment system shall be of a continuous type constructed of 3/16" x 1" steel with punched net attachment slots suitable for nylon or chain nets. Individual or continuous wire formed netlocks are not an acceptable equal. Include mounting hardware. Coordinate rim to fit backboard.
4. Net: Nylon.

2.4 FABRICATION

- A. Provide sizes, strengths, thicknesses, wall thickness, and weights of components as required to comply with requirements in ASTM F 1487. Factory drill components for field assembly. Unnecessary holes in components, not required for field assembly, are not permitted. Provide

complete play structures, including supporting members and connections, means of access and egress, designated play surfaces, barriers, guardrails, handrails, handholds, and other components indicated or required for equipment indicated.

- B. Metal Frame: Fabricate main-frame upright support posts from metal pipe or tubing with cross-section profile and dimensions as required. Unless otherwise indicated, provide each pipe or tubing main-frame member with manufacturer's standard drainable bottom plate or support flange. Fabricate secondary frame members, bracing, and connections from either steel or aluminum.
- C. Composite Frame: Fabricate main-frame upright support posts from metal and plastic. Fabricate secondary frame members, bracing, and connections from either steel or aluminum.
- D. Play Surfaces: Manufacturer's standard elevated drainable decks, platforms, landings, walkways, ramps, and similar transitional play surfaces, designed to withstand loads; fabricated from perforated or expanded metal made into floor units with slip-resistant finish. Fabricate units in modular sizes and shapes to form assembled play surfaces indicated.
- E. Protective Barriers: Fabricate according to ASTM F 1487. Extend barriers to height above the protected elevated surface according to requirements for use by age group indicated. Fabricate from the following:
 - 1. Welded-metal pipe or tubing with vertical bars.

2.5 MATERIALS

- A. Aluminum: Material, alloy, and temper recommended by manufacturer for type of use and finish indicated.
- B. Steel: Material types, alloys, and forms recommended by manufacturer for type of use and finish indicated.
- C. Stainless-Steel Sheet: Type 304; finished on exposed faces with No. 2B finish.
- D. Opaque Plastics: Color impregnated, UV stabilized, and mold resistant.
- E. Suspension Chain and Fittings: ASTM A 467/A 467M, Class CS, 4/0 or 5/0, welded-straight-link coil chain; hot-dip galvanized; with commercial-quality, hot-dip galvanized steel connectors and swing or ring hangers.
- F. Iron Castings and Hangers: Malleable iron, ASTM A 47/A 47M, Grade 32510, hot-dip galvanized.
- G. Post Caps: Cast aluminum or color-impregnated, UV-stabilized, mold-resistant polyethylene or polypropylene; color to match posts.
- H. Platform Clamps and Hangers: Cast aluminum or zinc-plated steel, not less than 0.105-inch-nominal thickness.

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- I. Hardware: Manufacturer's standard; commercial-quality; corrosion-resistant; hot-dip galvanized steel and iron, stainless steel, or aluminum; of a vandal-resistant design.
- J. Fasteners: Manufacturer's standard; corrosion-resistant; hot-dip galvanized or zinc-plated steel and iron, or stainless steel; permanently capped; and theft resistant.

2.6 CAST-IN-PLACE CONCRETE

- A. Concrete Materials and Properties: Comply with requirements in Section 033000 "Cast-in-Place Concrete" for normal-weight concrete with minimum 28-day compressive strength of 3000 psi, 3-inch slump, and 1-inch- maximum-size aggregate.

2.7 ALUMINUM FINISHES

- A. Baked-Enamel or Powder-Coat Finish: Minimum dry film thickness of 1.5 mils, medium gloss. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
- B. PVC Finish: UV-stabilized, mold-resistant, slip-resistant, matte-textured, dipped or sprayed-on PVC finish, with flame retardant added, and with minimum dry film thickness of 80 mils. Comply with coating manufacturer's written instructions for pretreatment and application.

2.8 IRON AND STEEL FINISHES

- A. Baked-Enamel or Powder-Coat Finish: After cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat to a minimum dry film thickness of 2 mils. Comply with coating manufacturer's written instructions for pretreatment, applying, and baking.
- B. PVC Finish: UV-stabilized, mold-resistant, slip-resistant, matte-textured, dipped or sprayed-on PVC finish, with flame retardant added, and with minimum dry film thickness of 80 mils. Comply with coating manufacturer's written instructions for pretreatment and application.

2.9 STAINLESS-STEEL FINISHES

- A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
- B. Bright, Cold-Rolled, Unpolished Finish: No. 2B.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for earthwork, subgrade elevations, surface and subgrade drainage, and other conditions affecting performance of the Work.
 - 1. Do not begin installation before final grading required for placing playground equipment and protective surfacing is completed.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with manufacturer's written installation instructions for each equipment type unless more stringent requirements are indicated. Anchor playground equipment securely, positioned at locations and elevations indicated.
 - 1. Maximum Equipment Height: Coordinate installed fall heights of equipment with finished elevations and critical-height values of protective surfacing. Set equipment so fall heights and elevation requirements for age group use and accessibility are within required limits. Verify that playground equipment elevations comply with requirements for each type and component of equipment.
- B. Post and Footing Excavation: Excavate holes for posts and footings as indicated in firm, undisturbed or compacted subgrade soil.
- C. Post Set with Concrete Footing: Comply with Section 033000 "Cast-in-Place Concrete" for measuring, batching, mixing, transporting, forming, and placing concrete.
 - 1. Set equipment posts in concrete footing. Protect portion of posts above footing from concrete splatter. Verify that posts are set plumb or at the correct angle, alignment, height, and spacing.
 - a. Place concrete around posts and vibrate or tamp for consolidation. Hold posts in position during placement and finishing operations until concrete is sufficiently cured.
 - 2. Embedded Items: Follow equipment manufacturer's written instructions and drawings to ensure correct installation of anchorages for equipment.
 - 3. Finishing Footings: Smooth top, and shape to shed water.

3.3 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

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- B. Perform the following tests and inspections with the assistance of a factory-authorized service representative.
 - 1. Perform inspection and testing for each type of installed playground equipment according to ASTM F 1487.
- C. Playground equipment items will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.
- E. Notify Architect 48 hours in advance of date(s) and time(s) of testing and inspection.

END OF SECTION

SECTION 122413 - ROLLER WINDOW SHADES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

- 1. Manually operated roller shades with single rollers.
- 2. Motor-operated roller shades with single rollers.

B. Related Requirements:

- 1. Section 061053 "Miscellaneous Rough Carpentry" for wood blocking and grounds for mounting roller shades and accessories.
- 2. Section 079200 "Joint Sealants" for sealing the perimeters of installation accessories for light-blocking shades with a sealant.

1.3 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.

B. Product Data: For each type of product.

- 1. Include construction details, material descriptions, dimensions of individual components and profiles, features, finishes, and operating instructions for roller shades.

C. Shop Drawings: Show fabrication and installation details for roller shades, including shadeband materials, their orientation to rollers, and their seam and batten locations.

- 1. Motor-Operated Shades: Include details of installation and diagrams for power, signal, and control wiring.

D. Samples: For each exposed product and for each color and texture specified, 10 inches long.

E. Samples for Initial Selection: For each type and color of shadeband material.

- 1. Include Samples of accessories involving color selection.

F. Samples for Verification: For each type of roller shade.

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1. Shadeband Material: Not less than 3 inches square. Mark interior face of material if applicable.
2. Roller Shade: Full-size operating unit, not less than 16 inches wide by 36 inches long for each type of roller shade indicated.
3. Installation Accessories: Full-size unit, not less than 10 inches long.

G. Product Schedule: For roller shades. Use same designations indicated on Drawings.

1.4 INFORMATIONAL SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Qualification Data: For Installer.
- C. Product Certificates: For each type of shadeband material.
- D. Product Test Reports: For each type of shadeband material, for tests performed by manufacturer and witnessed by a qualified testing agency or a qualified testing agency.

1.5 CLOSEOUT SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Operation and Maintenance Data: For roller shades to include in maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Fabricator of products.
- B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.
 1. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver roller shades in factory packages, marked with manufacturer, product name, and location of installation using same designations indicated on Drawings.

1.8 FIELD CONDITIONS

- A. Environmental Limitations: Do not install roller shades until construction and finish work in spaces, including painting, is complete and dry and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
- B. Field Measurements: Where roller shades are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Allow clearances for operating hardware of operable glazed units through entire operating range. Notify Architect of installation conditions that vary from Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain roller shades from single source from single manufacturer.

2.2 MANUALLY OPERATED SHADES WITH SINGLE ROLLERS (WS-1, WS-4)

- A. Basis-of-Design Product: Subject to compliance with requirements, provide “Mecho 5,” MechoShade Systems, Inc., or comparable product by one of the following:
 - 1. [BTX Window Automation Inc.](#)
 - 2. [DFB Sales Inc.](#)
 - 3. [Draper Inc.](#)
 - 4. [Hunter Douglas Contract.](#)
 - 5. [Insolroll Window Shading Systems.](#)
 - 6. [Lutron Electronics Co., Inc.](#)
 - 7. [OEM Shades Inc.](#)
 - 8. [Silent Gliss.](#)
 - 9. [SM Automatic, Inc.](#)
- B. Chain-and-Clutch Operating Mechanisms: With continuous-loop bead chain and clutch that stops shade movement when bead chain is released; permanently adjusted and lubricated.
 - 1. Bead Chains: Manufacturer's standard.
 - a. Loop Length: Full length of roller shade.
 - b. Limit Stops: Provide upper and lower ball stops.
 - c. Chain-Retainer Type: Clip, jamb mount.
 - 2. Spring Lift-Assist Mechanisms: Manufacturer's standard for balancing roller shade weight and for lifting heavy roller shades.

- a. Provide for shadebands that weigh more than 10 lb or for shades as recommended by manufacturer, whichever criterion is more stringent.
- C. Rollers: Corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shadebands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shadebands for service.
1. Roller Drive-End Location: Right side of interior face of shade.
 2. Direction of Shadeband Roll: Reverse, from front (interior face) of roller.
 3. Shadeband-to-Roller Attachment: Manufacturer's standard method.
- D. Mounting Hardware: Brackets or endcaps, corrosion resistant and compatible with roller assembly, operating mechanism, installation accessories, and mounting location and conditions indicated.
- E. Roller-Coupling Assemblies: Coordinated with operating mechanism and designed to join up to three inline rollers into a multiband shade that is operated by one roller drive-end assembly.
- F. Shadebands:
1. Shadeband Material: Light-filtering fabric standard:
 - a. WS-1: 1 percent openness.
 - b. WS-4: 0 percent openness.
 2. Shadeband Bottom (Hem) Bar: Steel or extruded aluminum.
 - a. Type: Enclosed in sealed pocket of shadeband material and exposed with endcaps.
 - b. Color and Finish: As selected by Architect from manufacturer's full range.
- G. Installation Accessories:
1. Front Fascia: Aluminum extrusion that conceals front and underside of roller and operating mechanism and attaches to roller endcaps without exposed fasteners.
 - a. Shape: L-shaped.
 - b. Height: Manufacturer's standard height required to conceal roller and shadeband assembly when shade is fully open, but not less than 4 inches.
 2. Exposed Headbox: Rectangular, extruded-aluminum enclosure including front fascia, top and back covers, endcaps, and removable bottom closure.
 - a. Height: Manufacturer's standard height required to enclose roller and shadeband assembly when shade is fully open, but not less than 4 inches.
 3. Endcap Covers: To cover exposed endcaps.
 4. Recessed Shade Pocket: Rectangular, extruded-aluminum enclosure designed for recessed ceiling installation; with front, top, and back formed as one piece, end plates, and removable bottom closure panel.

- a. Height: Manufacturer's standard height required to enclose roller and shadeband assembly when shade is fully open, but not less than 4 inches.
 - b. Provide pocket with lip at lower edge to support acoustical ceiling panel.
5. Closure Panel and Wall Clip: Removable aluminum panel designed for installation at bottom of site-constructed ceiling recess or pocket and for snap-in attachment to wall clip without fasteners.
- a. Closure-Panel Width: As indicated on Drawings.
6. Side Channels: With light seals and designed to eliminate light gaps at sides of shades as shades are drawn down. Provide side channels with shadeband guides or other means of aligning shadebands with channels at tops.
7. Bottom (Sill) Channel or Angle: With light seals and designed to eliminate light gaps at bottoms of shades when shades are closed.
8. Installation Accessories Color and Finish: As selected from manufacturer's full range.

2.3 MOTOR-OPERATED, SINGLE-ROLLER SHADES (WS-2)

- A. Basis-of-Design Product: Subject to compliance with requirements, provide "ElectroShade 3," MechoShade Systems, Inc. or comparable product by one of the following:
1. [BTX Window Automation Inc.](#)
 2. [DFB Sales Inc.](#)
 3. [Draper Inc.](#)
 4. [Hunter Douglas Contract.](#)
 5. [Insolroll Window Shading Systems.](#)
 6. [Lutron Electronics Co., Inc.](#)
 7. [OEM Shades Inc.](#)
 8. [Silent Gliss.](#)
 9. [SM Automatic, Inc.](#)
- B. Motorized Operating System: Provide factory-assembled, shade-operator system of size and capacity and with features, characteristics, and accessories suitable for conditions indicated, complete with electric motor and factory-prewired motor controls, power disconnect switch, enclosures protecting controls and operating parts, and accessories required for reliable operation without malfunction. Include wiring from motor controls to motors. Coordinate operator wiring requirements and electrical characteristics with building electrical system.
1. Electrical Components: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Electric Motor: Manufacturer's standard tubular, enclosed in roller.
 - a. Electrical Characteristics: 220-V ac.
 - b. Maximum Total Shade Width: As required to operate roller shades indicated.
 - c. Maximum Shade Drop: As required to operate roller shades indicated.
 - d. Maximum Weight Capacity: As required to operate roller shades indicated.

3. Remote Control: Electric controls with NEMA ICS 6, Type 1 enclosure for recessed or flush mounting. Provide the following for remote-control activation of shades:
 - a. Group Control Station: Keyed, mainted-contact, three-position, rocker-style, wall-switch-operated control station with open, close, and center off functions for single-switch group control. Provide two keys per station.
 - b. Color: As selected by Architect from manufacturer's full range.
 4. Limit Switches: Adjustable switches interlocked with motor controls and set to stop shades automatically at fully raised and fully lowered positions.
 5. Operating Features:
 - a. Group switching with integrated switch control; single faceplate for multiple switch cutouts.
 - b. Capable of accepting input from building automation control system.
 - c. Override switch.
- C. Rollers: Corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shadebands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shadebands for service.
1. Roller Drive-End Location: Right side of interior face of shade.
 2. Direction of Shadeband Roll: Reverse, from front (interior face) of roller.
 3. Shadeband-to-Roller Attachment: Manufacturer's standard method.
- D. Mounting Hardware: Brackets or endcaps, corrosion resistant and compatible with roller assembly, operating mechanism, installation accessories, and mounting location and conditions indicated.
- E. Roller-Coupling Assemblies: Coordinated with operating mechanism and designed to join up to three inline rollers that are operated by one roller drive-end assembly.
- F. Shadebands:
1. Shadeband Material: Light-filtering fabric.
 2. Shadeband Bottom (Hem) Bar: Steel or extruded aluminum.
 - a. Type: Enclosed in sealed pocket of shadeband material and exposed with endcaps.
 - b. Color and Finish: As selected by Architect from manufacturer's full range.
- G. Installation Accessories:
1. Front Fascia: Aluminum extrusion that conceals front and underside of roller and operating mechanism and attaches to roller endcaps without exposed fasteners.
 - a. Shape: L-shaped.
 - b. Height: Manufacturer's standard height required to conceal roller and shadeband assembly when shade is fully open, but not less than 4 inches.

2. Exposed Headbox: Rectangular, extruded-aluminum enclosure including front fascia, top and back covers, endcaps, and removable bottom closure.
 - a. Height: Manufacturer's standard in height required to enclose roller and shadeband assembly when shade is fully open, but not less than 4 inches.
3. Endcap Covers: To cover exposed endcaps.
4. Recessed Shade Pocket: Rectangular, extruded-aluminum enclosure designed for recessed ceiling installation; with front, top, and back formed as one piece, end plates, and removable bottom closure panel.
 - a. Height: Manufacturer's standard height required to enclose roller and shadeband assembly when shade is fully open, but not less than 4 inches.
 - b. Provide pocket with lip at lower edge to support acoustical ceiling panel.
5. Closure Panel and Wall Clip: Removable aluminum panel designed for installation at bottom of site-constructed ceiling recess or pocket and for snap-in attachment to wall clip without fasteners.
 - a. Closure-Panel Width: As indicated on Drawings.

2.4 MANUALLY OPERATED DOOR SHADE (WS-3)

- A. Basis-of-Design Product: Subject to compliance with requirements, provide "Hideaway Helper," Schod Safety Solutions, LLC.
- B. Material: 100 percent black fire retardant polyester.
- C. Weight: Minimum 20 oz.
- D. Thickness: 22 mil.
- E. Mounting Hardware: Velcro.
- F. Size: 28 by 34 inches or as necessary to cover entire window.

2.5 SHADEBAND MATERIALS

- A. Shadeband Material Flame-Resistance Rating: Comply with NFPA 701. Testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
- B. Light-Filtering Fabric: Woven fabric, stain and fade resistant.
 1. Source: Roller shade manufacturer.
 2. Type: Woven PVC-coated fiberglass and PVC-coated polyester.
 3. Weave: Basketweave.
 4. Thickness: 32 mil.
 5. Weight: 16 oz./sq. yd.
 6. Roll Width: 72 inches.

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7. Orientation on Shadeband: Up the bolt.
 8. Openness Factor:
 - a. WS-1: 1 percent.
 - b. WS-2: 2 percent
 9. Color: As selected by Architect from manufacturer's full range.
- C. Light-Blocking Fabric: Opaque fabric, stain and fade resistant (WS-4):
1. Source: Roller shade manufacturer.
 2. Type: Woven PVC-coated fiberglass and PVC-coated polyester.
 3. Thickness: 14 mil.
 4. Weight: 14 oz./sq. yd.
 5. Roll Width: 72 inches.
 6. Orientation on Shadeband: Up the bolt.
 7. Features: Washable.
 8. Color: As selected by Architect from manufacturer's full range.

2.6 ROLLER SHADE FABRICATION

- A. Product Safety Standard: Fabricate roller shades to comply with WCMA A 100.1, including requirements for flexible, chain-loop devices; lead content of components; and warning labels.
- B. Unit Sizes: Fabricate units in sizes to fill window and other openings as follows, measured at 74 deg F:
1. Between (Inside) Jamb Installation: Width equal to jamb-to-jamb dimension of opening in which shade is installed less 1/4 inch per side or 1/2-inch total, plus or minus 1/8 inch. Length equal to head-to-sill or -floor dimension of opening in which shade is installed less 1/4 inch, plus or minus 1/8 inch.
 2. Outside of Jamb Installation: Width and length as indicated, with terminations between shades of end-to-end installations at centerlines of mullion or other defined vertical separations between openings.
- C. Shadeband Fabrication: Fabricate shadebands without battens or seams to extent possible, except as follows:
1. Vertical Shades: Where width-to-length ratio of shadeband is equal to or greater than 1:4, provide battens and seams at uniform spacings along shadeband length to ensure shadeband tracking and alignment through its full range of movement without distortion of the material.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, operational clearances, locations of connections to building electrical system, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 ROLLER SHADE AND DOOR SHADE INSTALLATION

- A. Install shades level, plumb, and aligned with adjacent units according to manufacturer's written instructions.
 - 1. Opaque Shadebands: Located so shadeband is not closer than 2 inches to interior face of glass. Allow clearances for window operation hardware.
- B. Electrical Connections: Connect motor-operated roller shades to building electrical system.
- C. Shade Locations: As indicated on Drawings.

3.3 ADJUSTING

- A. Adjust and balance roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.

3.4 CLEANING AND PROTECTION

- A. Clean roller shade surfaces, after installation, according to manufacturer's written instructions.
- B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that roller shades are without damage or deterioration at time of Substantial Completion.
- C. Replace damaged roller shades that cannot be repaired, in a manner approved by Architect, before time of Substantial Completion.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain motor-operated roller shades.

END OF SECTION

SECTION 123623.13 - PLASTIC-LAMINATE-CLAD COUNTERTOPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes plastic-laminate-clad countertops.

1.3 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Product Data: For each type of product.
 - 1. Include data for fire-retardant treatment from chemical-treatment manufacturer and certification by treating plant that treated materials comply with requirements.
- C. Sustainable Design Submittals:
 - 1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
 - 2. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
 - 3. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.
 - 4. Product Data: For adhesives, indicating that product contains no urea formaldehyde.
 - 5. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
 - 6. Product Data: For installation adhesives, indicating VOC content.
 - 7. Laboratory Test Reports: For installation adhesives, indicating compliance with requirements for low-emitting materials.
 - 8. Product Data: For composite wood products, indicating that product contains no urea formaldehyde.
 - 9. Laboratory Test Reports: For composite wood products, indicating compliance with requirements for low-emitting materials.
- D. Shop Drawings: For plastic-laminate-clad countertops.

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1. Include plans, sections, details, and attachments to other work. Detail fabrication and installation, including field joints.
 2. Show locations and sizes of cutouts and holes for items installed in plastic-laminate-clad countertops.
 3. Apply AWI Quality Certification Program label to Shop Drawings.
- E. Samples: Plastic laminates in each type, color, pattern, and surface finish required in manufacturer's standard size.
- F. Samples for Initial Selection: For plastic laminates.
- G. Samples for Verification: As follows:
1. Plastic Laminates: For each type, color, pattern, and surface finish required, 12 by 12 inches in size.
 2. Fabrication Sample: For each type and profile of countertop required, provide one sample applied to core material with specified edge material applied to one edge.

1.4 INFORMATIONAL SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Qualification Data: For Installer and fabricator.
- C. Product Certificates: For the following:
1. Composite wood and agrifiber products.
 2. High-pressure decorative laminate.
 3. Chemical-resistant, high-pressure decorative laminate.
 4. Adhesives.
- D. Quality Standard Compliance Certificates: AWI Quality Certification Program.
- E. Evaluation Reports: For fire-retardant-treated materials, from ICC-ES.

1.5 QUALITY ASSURANCE

- A. Fabricator Qualifications: Shop that employs skilled workers who custom fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.
1. Shop Certification: AWI's Quality Certification Program accredited participant.
- B. Installer Qualifications: Fabricator of products.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver countertops only after casework and supports on which they will be installed have been completed in installation areas.
- B. Store countertops in areas where environmental conditions comply with requirements specified in "Field Conditions" Article.
- C. Keep surfaces of countertops covered with protective covering during handling and installation.

1.7 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install countertops until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature between 60 and 90 deg F and relative humidity between 25 and 55 percent during the remainder of the construction period.
- B. Field Measurements: Where countertops are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
- C. Established Dimensions: Where countertops are indicated to fit to other construction, establish dimensions for areas where countertops are to fit. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

PART 2 - PRODUCTS

2.1 PLASTIC-LAMINATE-CLAD COUNTERTOPS

- A. Quality Standard: Unless otherwise indicated, comply with the "Architectural Woodwork Standards" for grades of plastic-laminate-clad countertops indicated for construction, finishes, installation, and other requirements.
- B. Grade: Custom.
- C. **Regional Materials:** Wood products shall be manufactured within 500 miles of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site.
- D. Regional Materials: Wood products shall be manufactured within 500 miles of Project site.
- E. **Certified Wood:** Wood products shall be certified as "FSC Pure" according to FSC STD-01-001 and FSC STD-40-004.
- F. High-Pressure Decorative Laminate: NEMA LD 3, Grade HGS.

1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. [Abet Laminati Inc.](#)
 - b. [Formica Corporation.](#)
 - c. [Lamin-Art, Inc.](#)
 - d. [Nevamar; a Panolam Industries International, Inc. brand.](#)
 - e. [Pionite; a Panolam Industries International, Inc. brand.](#)
 - f. [Wilsonart.](#)

G. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:

1. As indicated by manufacturer's designations.
2. Match Architect's sample.
3. As selected by Architect from manufacturer's full range in the following categories:
 - a. Solid colors, matte finish.
 - b. Patterns, matte finish.

H. Edge Treatment: Same as laminate cladding on horizontal surfaces.

I. Core Material: Particleboard or straw-based particleboard.

J. Core Material at Sinks: Particleboard made with exterior glue.

K. Core Thickness: 3/4 inch.

1. Build up countertop thickness to 1-1/2 inches at front, back, and ends with additional layers of core material laminated to top.

2.2 WOOD MATERIALS

A. Wood Products: Provide materials that comply with requirements of referenced quality standard unless otherwise indicated.

1. Wood Moisture Content: 5 to 10 percent.

B. Composite Wood and Agrifiber Products: Provide materials that comply with requirements of referenced quality standard for each type of countertop and quality grade specified unless otherwise indicated.

1. **Composite Wood Products:** Products shall be made without urea formaldehyde.
2. Composite Wood Products: Products 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."
3. **Recycled Content of MDF and Particleboard:** Postconsumer recycled content plus one-half of preconsumer recycled content not less than 80 percent.

4. Particleboard: ANSI A208.1, Grade M-2.
5. Straw-Based Particleboard: ANSI A208.1, Grade M-2, except for density.
 - a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
 - 1) Panel Source International, Inc.; Purekor Ag Fiber Particleboard.
 - 2) Sorm Incorporated; Primeboard Premium Wheat.

2.3 ACCESSORIES

- A. Wire-Management Grommets: Circular, molded-plastic grommets and matching plastic caps with slot for wire passage.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Doug Mockett & Company, Inc.
 2. Outside Diameter: 1-1/4 inch.
 3. Color: Black,

2.4 MISCELLANEOUS MATERIALS

- A. Adhesives: Do not use adhesives that contain urea formaldehyde.
- B. Adhesives: Use adhesives that meet the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- C. Adhesive for Bonding Plastic Laminate: Contact cement.
 1. Adhesive for Bonding Edges: Hot-melt adhesive or adhesive specified above for faces.
- D. Installation Adhesive:
 1. Adhesives shall have a VOC content of 70 g/L or less.
 2. Adhesive 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."

2.5 FABRICATION

- A. Fabricate countertops to dimensions, profiles, and details indicated. Provide front and end overhang of 1 inch over base cabinets. Ease edges to radius indicated for the following:

1. Solid-Wood (Lumber) Members: 1/16 inch unless otherwise indicated.
- B. Complete fabrication, including assembly, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
 1. Notify Architect seven days in advance of the dates and times countertop fabrication will be complete.
 2. Trial fit assemblies at fabrication shop that cannot be shipped completely assembled. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting. Verify that various parts fit as intended, and check measurements of assemblies against field measurements before disassembling for shipment.
- C. Shop cut openings to maximum extent possible to receive appliances, plumbing fixtures, electrical work, and similar items. Locate openings accurately, and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.
 1. Seal edges of cutouts by saturating with varnish.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Before installation, condition countertops to average prevailing humidity conditions in installation areas.
- B. Before installing countertops, examine shop-fabricated work for completion and complete work as required, including removal of packing.

3.2 INSTALLATION

- A. Grade: Install countertops to comply with same grade as item to be installed.
- B. Assemble countertops and complete fabrication at Project site to the extent that it was not completed in the shop.
 1. Provide cutouts for appliances, plumbing fixtures, electrical work, and similar items. Locate openings accurately, and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.
 2. Seal edges of cutouts by saturating with varnish.

- C. Field Jointing: Where possible, make in the same manner as shop jointing, using dowels, splines, adhesives, and fasteners recommended by manufacturer. Prepare edges to be joined in shop so Project-site processing of top and edge surfaces is not required. Locate field joints where shown on Shop Drawings.
 - 1. Secure field joints in countertops with concealed clamping devices located within 6 inches of front and back edges and at intervals not exceeding 24 inches. Tighten according to manufacturer's written instructions to exert a constant, heavy-clamping pressure at joints.
- D. Scribe and cut countertops to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
- E. Countertop Installation: Anchor securely by screwing through corner blocks of base cabinets or other supports into underside of countertop.
 - 1. Install countertops level and true in line. Use concealed shims as required to maintain not more than a 1/8-inch-in-96-inches variation from a straight, level plane.
 - 2. Seal joints between countertop and backsplash, if any, and joints where countertop and backsplash abut walls with mildew-resistant silicone sealant or another permanently elastic sealing compound recommended by countertop material manufacturer.

3.3 ADJUSTING AND CLEANING

- A. Repair damaged and defective countertops, where possible, to eliminate functional and visual defects. Where not possible to repair, replace countertops. Adjust joinery for uniform appearance.
- B. Clean countertops on exposed and semi-exposed surfaces.
- C. Protection: Provide Kraft paper or other suitable covering over countertop surfaces, taped to underside of countertop at a minimum of 48 inches o.c. Remove protection at Substantial Completion.

END OF SECTION

SECTION 123661.16 - SOLID SURFACING COUNTERTOPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Solid surface material countertops.
2. Solid surface material backsplashes.
3. Solid surface material apron fronts.
4. Solid surface material sinks.

B. Related Requirements:

1. Section 224100 "Residential Plumbing Fixtures" for non-integral sinks and plumbing fittings.

1.3 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.

- B. Product Data: For countertop materials.

C. Sustainable Design Submittals:

1. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.
2. Product Data: For adhesives, indicating VOC content.
3. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
4. Product Data: For composite wood products, indicating that product contains no urea formaldehyde.
5. Laboratory Test Reports: For composite wood products, indicating compliance with requirements for low-emitting materials.

- D. Shop Drawings: For countertops. Show materials, finishes, edge and backsplash profiles, methods of joining, and cutouts for plumbing fixtures.

1. Show locations and details of joints.
2. Show direction of directional pattern, if any.

- E. Samples for Initial Selection: For each type of material exposed to view.
- F. Samples for Verification: For the following products:
 - 1. Countertop material, 6 inches square.

1.4 INFORMATIONAL SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 “Submittal Procedures” and the individual sections specifying the work.
- B. Qualification Data: For fabricator.

1.5 CLOSEOUT SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 “Submittal Procedures” and the individual sections specifying the work.
- B. Maintenance Data: For solid surface material countertops to include in maintenance manuals. Include Product Data for care products used or recommended by Installer and names, addresses, and telephone numbers of local sources for products.

1.6 QUALITY ASSURANCE

- A. Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate countertops similar to that required for this Project, and whose products have a record of successful in-service performance.
- B. Installer Qualifications: Fabricator of countertops.
- C. Mockups: Build mockups to demonstrate aesthetic effects and to set quality standards for fabrication and execution.
 - 1. Build mockup of typical countertop as shown on Drawings.
 - 2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 FIELD CONDITIONS

- A. Field Measurements: Verify dimensions of countertops by field measurements before countertop fabrication is complete.

1.8 COORDINATION

- A. Coordinate locations of utilities that will penetrate countertops or backsplashes.

PART 2 - PRODUCTS

2.1 SOLID SURFACE COUNTERTOP MATERIALS

- A. Solid Surface Material: Homogeneous-filled plastic resin complying with ICPA SS-1.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Avonite Surfaces.
 - b. E. I. du Pont de Nemours and Company.
 - c. Formica Corporation.
 - d. Living Stone Surfaces.
 - e. Samsung Chemical USA, Inc.
 - f. Wilsonart.
 2. Integral Sink Bowls: Comply with CSA B45.5/IAPMO Z124.
 - a. Basis-of-Design: Corian 815 ADA compliant.
 3. Colors and Patterns: As selected by Architect from manufacturer's full range.
- B. Particleboard: ANSI A208.1, Grade M-2.

2.2 COUNTERTOP FABRICATION

- A. Fabricate countertops according to solid surface material manufacturer's written instructions and to the AWI/AWMAC/WI's "Architectural Woodwork Standards."
1. Grade: Custom.
- B. Configuration:
1. Front: Radius and apron as indicated on Drawings.
 2. Backsplash: Straight, slightly eased at corner.
- C. Countertops: 1/2-inch-thick, solid surface material with front edge built up with same material.
- D. Backsplashes: 1/2-inch-thick, solid surface material.
- E. Fabricate tops with shop-applied edges and backsplashes unless otherwise indicated. Comply with solid surface material manufacturer's written instructions for adhesives, sealers, fabrication, and finishing.
1. Install integral sink bowls in countertops in the shop. Mount sinks in underside mounting configuration.
- F. Joints: Fabricate countertops in sections for joining in field, with joints at locations indicated on approved shop drawings.

1. Joint Locations: Not within 18 inches of a sink or cooktop and not where a countertop section less than 36 inches long would result, unless unavoidable.
2. Splined Joints: Accurately cut kerfs in edges at joints for insertion of metal splines to maintain alignment of surfaces at joints. Make width of cuts slightly more than thickness of splines to provide snug fit. Provide at least three splines in each joint.

G. Cutouts and Holes:

1. Undercounter Plumbing Fixtures: Make cutouts for fixtures in shop using template or pattern furnished by fixture manufacturer. Form cutouts to smooth, even curves.
 - a. Provide vertical edges, slightly eased at juncture of cutout edges with top and bottom surfaces of countertop and projecting 3/16 inch into fixture opening.
2. Fittings: Drill countertops in shop for plumbing fittings, undercounter soap dispensers, and similar items.

2.3 INSTALLATION MATERIALS

A. Adhesive: Product recommended by solid surface material manufacturer.

1. Adhesives shall have a VOC content of 70 g/L or less.
2. Adhesive 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. Sealant for Countertops: Comply with applicable requirements in Section 079200 "Joint Sealants."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates to receive solid surface material countertops and conditions under which countertops will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of countertops.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install countertops level to a tolerance of 1/8 inch in 8 feet, 1/4 inch maximum. Do not exceed 1/64-inch difference between planes of adjacent units.
- B. Fasten countertops by screwing through corner blocks of base units into underside of countertop. Pre-drill holes for screws as recommended by manufacturer. Align adjacent surfaces

and, using adhesive in color to match countertop, form seams to comply with manufacturer's written instructions. Carefully dress joints smooth, remove surface scratches, and clean entire surface.

- C. Fasten subtops to cabinets by screwing through subtops into cornerblocks of base cabinets. Shim as needed to align subtops in a level plane.
- D. Secure countertops to subtops with adhesive according to solid surface material manufacturer's written instructions. Align adjacent surfaces and, using adhesive in color to match countertop, form seams to comply with manufacturer's written instructions. Carefully dress joints smooth, remove surface scratches, and clean entire surface.
- E. Bond joints with adhesive and draw tight as countertops are set. Mask areas of countertops adjacent to joints to prevent adhesive smears.
 - 1. Install metal splines in kerfs in countertop edges at joints. Fill kerfs with adhesive before inserting splines and remove excess immediately after adjoining units are drawn into position.
 - 2. Clamp units to temporary bracing, supports, or each other to ensure that countertops are properly aligned and joints are of specified width.
- F. Install backsplashes and end splashes by adhering to wall and countertops with adhesive. Mask areas of countertops and splashes adjacent to joints to prevent adhesive smears.
- G. Install aprons to backing and countertops with adhesive. Mask areas of countertops and splashes adjacent to joints to prevent adhesive smears. Fasten by screwing through backing. Predrill holes for screws as recommended by manufacturer.
- H. Complete cutouts not finished in shop. Mask areas of countertops adjacent to cutouts to prevent damage while cutting. Make cutouts to accurately fit items to be installed, and at right angles to finished surfaces unless beveling is required for clearance. Ease edges slightly to prevent snipping.
 - 1. Seal edges of cutouts in particleboard subtops by saturating with varnish.
- I. Apply sealant to gaps at walls; comply with Section 079200 "Joint Sealants."

END OF SECTION

SECTION 126600 - TELESCOPING STANDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Electrically operated telescoping stands.

1.3 DEFINITIONS

- A. Forward Folding: Wall- or floor-attached bleachers that open in the forward direction by moving the front row away from the stack to the fully extended position.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for telescoping stands.
 - 2. Include load capacities, assembly characteristics, and furnished accessories.
 - 3. Include electrical characteristics of electrical components, devices, and accessories.
- C. Sustainable Design Submittals:
 - 1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
 - 2. Chain-of-Custody Certificates: For certified wood products. Include statement of costs.
 - 3. Chain-of-Custody Qualification Data: For manufacturer and vendor.

4. **Product Data:** For composite wood products, indicating that product contains no urea formaldehyde.
 5. **Laboratory Test Reports:** For composite wood products, indicating compliance with requirements for low-emitting materials.
- D. **Shop Drawings:** For telescoping stands in both stacked and extended positions.
1. Include plans, elevations, sections, and attachment details.
 2. Include load capacities.
 3. Show seating layout, aisle widths, row-lettering and seat-numbering scheme, and wheelchair accessibility provisions.
 4. Show locations and details for installing operator components, switches, and controls. Indicate motor size, electrical characteristics, drive arrangement, mounting, and grounding provisions.
 5. Include diagrams for power, signal, and control wiring.
- E. **Samples for Initial Selection:** For each type of exposed product and for each color and texture required.
1. Include Samples of accessories involving color and finish selection.
- F. **Samples for Verification:** For the following products prepared on Samples of size indicated below:
1. **Decking:** 6-inch-square Samples of finished material.
 2. **Metal Components:** 6-inch-square Sample of each color and finish indicated.
 3. **Seating Material:** 6-inch-square Sample of each seating material, color, and finish indicated.
 4. **Signage:** Full-size units for row letters each type of accessibility sign and custom graphics.
- 1.6 **INFORMATIONAL SUBMITTALS**
- A. Submittals shall comply with the requirements of Section 013300 “Submittal Procedures” and the individual sections specifying the work.
 - B. **Qualification Data:** For Installer.
 - C. **Welding certificates.**
 - D. **Product Certificates:** For each type of telescoping stand assembly.
 - E. **Material Certificates:** For each type of flame-retardant treatment of upholstery fabric.
 - F. **Field quality-control reports.**

1.7 CLOSEOUT SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Operation and Maintenance Data: For telescoping stands to include in operation and maintenance manuals.
 - 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - a. Procedures for conducting periodic inspections.
 - b. Precautions for cleaning materials and methods that could be detrimental to telescoping-stand finishes and performance.
 - c. Methods for maintaining upholstery fabric.

1.8 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.
- B. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.
- C. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
- D. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
 - 2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."
- E. Mockups: Build mockups to demonstrate aesthetic effects and to set quality standards for fabrication and installation.
 - 1. Build mockup of typical telescoping stand as shown selected by Architect.
 - 2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 FIELD CONDITIONS

- A. Finished Spaces: Do not deliver or install telescoping stands until finishes in spaces to receive them are complete, including suspended ceilings, floors, and painting.
- B. Field Measurements: Indicate measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Telescoping stands shall withstand the effects of gravity loads, operational loads, and other loads and stresses according to ICC 300.
- B. Accessibility Standard: Comply with applicable provisions in the ABA Standards of the Federal agency having jurisdiction.

2.2 TELESCOPING STANDS

- A. System Description: Operable system of multiple-tiered seating on interconnected folding platforms that close for storage, without being dismantled, into a nested stack. Telescoping-stand units permit opening and closing of adjacent, individual and multiple rows, and close with vertical faces of platforms in the same vertical plane.
 - 1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Telescoping-Stands Standard: ICC 300.
- B. Wall-Attached Telescoping Stands: Forward-folding system, in which the bleachers open in the forward direction by moving the front row away from the stack to the fully extended position and the rear of bleacher understructure permanently attaches to wall construction.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide “MAXAM – Wall Attached Telescopic Gym Seating,” Hussey Seating Corporation, or comparable product by one of the following:
 - a. Interkal LLC.
 - b. Irwin Telescopic Seating Company; Irwin Seating Company.
 - c. Royal Stewart Ltd.
 - 2. Row Spacing: 26 inches.
 - 3. Row Rise: 9-5/8 inches.
 - 4. Seat Type: Benches.
 - 5. Operation: Manually operated and electrically operated, with friction-type, integral power unit as indicated on Drawings.
 - 6. Electrical Characteristics for Each Seating Section:
 - a. Horsepower: 1/4.
 - b. Voltage: 115 V ac, single phase, 60 hertz.
 - 7. Electrical Controls:
 - a. Control Devices: Wall-attached control system.

- b. Limit Switches: Automatically stop power system when telescoping stands reach fully opened or closed positions.
- c. Motion Monitor: Flashing light with self-contained warning horn, rated at 85 dB at 10 feet, mounted under telescoping seating for audio and visual warning during operation.
- d. Transformer: As required to coordinate current characteristics of motor and control station with building electrical system.

2.3 COMPONENTS

A. Benches: Seats and skirts.

- 1. Material: Lumber with transparent finish.
 - a. Color: As selected by Architect from manufacturer's standard.
- 2. Bench Height: Not less than 16 inches or more than 18 inches.
- 3. Bench Depth: 10 inches.

B. Wheelchair-Accessible Seating: Locate seating cutouts to provide wheelchair-accessible seating at locations indicated on Drawings.

- 1. Equip tiers adjacent to wheelchair-accessible seating with front rails as required by ICC 300.
- 2. Equip cutouts with full-width front closure panels that match decking construction and finish and that extend from underside of tiers adjacent to cutouts to 1-1/2 inches from finished floor.

C. Deck: Plywood, 3/4 inch thick.

- 1. Finish: Transparent.
 - a. Color: As selected by Architect from manufacturer's standard colors.

D. Risers: Steel sheet with manufacturer's standard, rust-inhibiting coating or hot-dip galvanized finish.

E. Safety Rails: Steel, finished with manufacturer's standard powder coat system.

- 1. Removable mid-aisle handrails located at centerline of each aisle with seating on both sides.
- 2. End rails (guards) that are telescoping and self-storing.
- 3. Removable rails around accessible seating cutouts and truncations.
- 4. Color: Black.

F. Understructure: Structural steel.

- 1. Finish: Manufacturer's standard rust-inhibiting finish.
- 2. Color: Manufacturer's standard.

- G. Support Column Wheels: Nonmarring, soft, rubber-face wheel assembly under each support column.
 - 1. Include wheels of size, number, and design required to support stands and operate smoothly without damaging the flooring surface, but no fewer than four per column or less than 4 inches in diameter and 1-1/2 inch wide.
- H. Control Devices:
 - 1. Wall Attached: Keyed-switch control station, located within full view of each stand and its movement area. Provide two keys per station.
- I. Fasteners: Vibration proof, in manufacturer's standard size and material.

2.4 ACCESSORIES

- A. Steps:
 - 1. Slip-resistant, abrasive tread surfaces at aisles.
 - 2. Intermediate aisle steps, fully enclosed, at each aisle.
 - 3. Transitional top step, fully enclosed, at each aisle where last row of telescoping stands is adjacent to a cross aisle.
 - 4. Removable front steps, fully enclosed, at each aisle, that engage with front row to prevent accidental separation or movement and are equipped with a minimum of four skid-resistant feet.
- B. Ramps: Portable access-ramp units, slope to comply with requirements of accessibility standard, equipped with handrails, with no fewer than four full-swiveling, nonmarring wheels and a locking mechanism to prevent movement during use.
- C. Closure Panels and Void Fillers:
 - 1. Aisle closures at foot level that produce flush vertical face at aisles when system is stored.
 - 2. End panels covering exposed ends of stands in the stored position.
 - 3. Panels at cutouts and truncations for accessible seating.
 - 4. Rear fillers including supports for closing openings between top row and rear wall of adjoining construction.
 - 5. Gap fillers for closing openings between stand units or between stand units and adjoining construction.
- D. Signage:
 - 1. Row letters at each row end.
 - 2. Accessibility signs at each accessible space.
 - 3. Custom graphics as indicated on Drawings.
- E. Scorer's Table: Removable unit that attaches to mounting sockets installed in telescoping stand unit.

2.5 MATERIALS

- A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [25] <Insert value> percent.
- B. Certified Wood: Wood products shall be certified as "FSC Pure"[or "FSC Mixed Credit"] according to FSC STD-01-001 and FSC STD-40-004.
- C. Composite Wood Products: Products shall be made without urea formaldehyde.
- D. Composite Wood Products: Products 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."
- E. Lumber: Kiln dried, surfaced four sides; southern pine complying with SPIB's "Standard Grading Rules for Southern Pine Lumber" for B & B finish (B and better) grade-of-finish requirements.
- F. Plywood: PS 1 as standard with manufacturer.

2.6 FABRICATION

- A. Fabricate telescoping stands to operate easily without special tools or separate fasteners unless otherwise indicated.
- B. Round corners and edges of components and exposed fasteners to reduce snagging and pinching hazards.
- C. Form exposed work with flat, flush surfaces, level and true in line.
- D. Supports: Fabricate supports to withstand, without damage to components, the forces imposed by use of stands without failure or other conditions that might impair their usefulness.
 - 1. Cantilever bench seat supports to produce toe space uninterrupted by vertical bracing.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install telescoping stands according to ICC 300 and manufacturer's written instructions.

3.3 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform the following tests and inspections:
 - 1. ICC 300 Inspection: Inspect installed telescoping stands to verify that construction, installation, and operation are according to ICC 300 requirements.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Telescoping stands will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

3.4 ADJUSTING

- A. Adjust backrests so that they are at proper angles and aligned with each other in uniform rows.
- B. Adjust hardware and moving parts to function smoothly, and lubricate, test, and adjust each telescoping stand unit to operate according to manufacturer's written instructions.
- C. Clean installed telescoping stands on exposed and semiexposed surfaces. Touch up factory-applied finishes or replace components as required to restore damaged or soiled areas.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to inspect, adjust, operate, and maintain telescoping stands.

END OF SECTION

SECTION 142400 - HYDRAULIC ELEVATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes hydraulic passenger elevators.
- B. Related Requirements:
 - 1. Section 033000 "Cast-in-Place Concrete" for setting sleeves, inserts, and anchoring devices in concrete.
 - 2. Section 042000 "Unit Masonry" for setting sleeves, inserts, and anchoring devices in masonry and for grouting elevator entrance frames installed in masonry walls.
 - 3. Section 055000 "Metal Fabrications" for the following:
 - a. Attachment plates and angle brackets for supporting guide-rail brackets.
 - b. Hoist beams.
 - c. Structural-steel shapes for subsills.
 - d. Pit ladders.
 - e. Cants made from steel sheet in hoistways.
 - 4. Section 096543 "Linoleum Flooring" for finish flooring in elevator cars.
 - 5. Section 099123 "Interior Painting" for field painting of hoistway entrance doors and frames.
 - 6. Section 221429 "Sump Pumps" for sump pumps, sumps, and sump covers in elevator pits.
 - 7. Section 271513 "Communications Copper Horizontal Cabling" for twisted pair conductors used for telephone service for elevators and for Internet connection to elevator controllers for remote monitoring of elevator performance if required.
 - 8. Section 283111 "Digital, Addressable Fire-Alarm System" for smoke detectors in elevator lobbies to initiate emergency recall operation and heat detectors in shafts and machine rooms to disconnect power from elevator equipment before sprinkler activation and for connection to elevator controllers.

1.3 DEFINITIONS

- A. Definitions in ASME A17.1/CSA B44 apply to work of this Section.
- B. Service Elevator: A passenger elevator that is also used to carry freight.

1.4 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 “Submittal Procedures” and the individual sections specifying the work.
- B. Product Data: Include capacities, sizes, performances, operations, safety features, finishes, and similar information. Include product data for car enclosures; hoistway entrances; and operation, control, and signal systems.
- C. Shop Drawings:
 - 1. Include plans, elevations, sections, and large-scale details indicating service at each landing; machine room layout; coordination with building structure; relationships with other construction; and locations of equipment.
 - 2. Include large-scale layout of car-control station.
 - 3. Indicate maximum dynamic and static loads imposed on building structure at points of support as well as maximum and average power demands.
- D. Samples for Initial Selection: For finishes involving color selection.
- E. Samples for Verification: For exposed car, hoistway door and frame, and signal equipment finishes, 3-inch- square Samples of sheet materials and 4-inch lengths of running trim members.

1.5 INFORMATIONAL SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 “Submittal Procedures” and the individual sections specifying the work.
- B. Qualification Data: For Installer.
- C. Seismic Qualification Certificates: For elevator equipment, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- D. Manufacturer Certificates: Signed by elevator manufacturer, certifying that hoistway, pit, and machine room layout and dimensions, as shown on Drawings, and electrical service, as shown and specified, are adequate for elevator system being provided.
- E. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 “Submittal Procedures” and the individual sections specifying the work.
- B. Operation and Maintenance Data: For elevators to include in emergency, operation, and maintenance manuals.
 - 1. Submit manufacturer's/installer's standard operation and maintenance manual, in accordance with ASME A17.1/CSA B44.
- C. Inspection and Acceptance Certificates and Operating Permits: As required by authorities having jurisdiction for normal, unrestricted elevator use.
- D. Continuing Maintenance Proposal: Submit a continuing maintenance proposal from Installer to Owner, in the form of a standard one-year maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Elevator manufacturer or an authorized representative who is trained and approved by manufacturer.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle materials, components and equipment in manufacturer's protective packaging. Store materials, components, and equipment off of ground, under cover, and in a dry location.

1.9 COORDINATION

- A. Coordinate installation of sleeves, block outs, elevator equipment with integral anchors, and other items that are embedded in concrete or masonry for elevator equipment. Furnish templates, sleeves, elevator equipment with integral anchors, and installation instructions and deliver to Project site in time for installation.
- B. Coordinate locations and dimensions of other work specified in other Sections that relates to hydraulic elevators, including pit ladders; sumps and floor drains in pits; entrance subsills; electrical service; and electrical outlets, lights, and switches in hoistways, pits, and machine rooms.

1.10 WARRANTY

- A. Manufacturer's Special Warranty: Manufacturer agrees to repair, restore, or replace elevator work that fails in materials or workmanship within specified warranty period.

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1. Failures include, but are not limited to, operation or control system failure, including excessive malfunctions; performances below specified ratings; excessive wear; unusual deterioration or aging of materials or finishes; unsafe conditions; need for excessive maintenance; abnormal noise or vibration; and similar unusual, unexpected, and unsatisfactory conditions.
2. Warranty Period: One year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 HYDRAULIC ELEVATOR MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide "HydroFit" Otis Elevator Co., or comparable product by one of the following:
 1. Canton Elevator, Inc.
 2. ThyssenKrupp Elevator.
- B. Source Limitations: Obtain elevators from single manufacturer.
 1. Major elevator components, including pump-and-tank units, plunger-cylinder assemblies, controllers, signal fixtures, door operators, car frames, cars, and entrances, shall be manufactured by single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Regulatory Requirements: Comply with ASME A17.1/CSA B44.
- B. Accessibility Requirements: Comply with Section 407 in the United States Access Board's ADA-ABA Accessibility Guidelines and with ICC A117.1.
- C. Seismic Performance: Elevator system shall withstand the effects of earthquake motions determined according to ASCE/SEI 7 and shall comply with elevator seismic requirements in ASME A17.1/CSA B44.
 1. The term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified."
 2. Project Seismic Design Category: C.
 3. Elevator Component Importance Factor: 1.0.
 4. Design earthquake spectral response acceleration short period (Sds) for Project is 0.484.
 5. Provide earthquake equipment required by ASME A17.1/CSA B44.
 6. Provide seismic switch required by ASCE/SEI 7.

2.3 ELEVATORS

- A. Elevator System, General: Manufacturer's standard elevator systems. Unless otherwise indicated, manufacturers' standard components shall be used, as included in standard elevator systems and as required for complete system.
- B. Elevator Description:
1. Type: Holeless, beside-the-car, single-acting, single cylinder, or
 2. Type: Holeless, beside-the-car, telescoping, single cylinder.
 3. Rated Load: 3500 lb.
 4. Freight Loading Class for Service Elevators: Class A.
 5. Rated Speed: 125 fpm.
 6. Operation System: Single automatic operation.
 7. Auxiliary Operations:
 - a. Battery-powered lowering.
 - b. Automatic operation of lights and ventilation fans.
 8. Security Features: Keyswitch operation.
 9. Car Enclosures:
 - a. Inside Width: Not less than 77-1/2 inches from side wall to side wall.
 - b. Inside Depth: Not less than 65-1/2 inches from back wall to front wall (return panels).
 - c. Inside Height: Not less than 93 inches to underside of ceiling.
 - d. Front Walls (Return Panels): Satin stainless steel, No. 4 finish with integral car door frames.
 - e. Car Fixtures: Satin stainless steel, No. 4 finish.
 - f. Side and Rear Wall Panels: Plastic laminate.
 - g. Reveals: Enameled or powder-coated steel.
 - h. Door Faces (Interior): Enameled or powder-coated steel.
 - i. Door Sills: Aluminum.
 - j. Ceiling: Luminous ceiling.
 - k. Handrails: 1-1/2 inches round, satin stainless steel, No. 4 finish, at sides and rear of car.
 - l. Floor prepared to receive resilient flooring (specified in Section 096543 "Linoleum Flooring").
 10. Hoistway Entrances:
 - a. Width: 42 inches.
 - b. Height: 84 inches.
 - c. Type: Single-speed side sliding.
 - d. Frames: Enameled or powder-coated steel.
 - e. Doors: Enameled or powder-coated steel.
 - f. Sills: Aluminum.
 11. Hall Fixtures: Satin stainless steel, No. 4 finish.
 12. Additional Requirements:

- a. Provide inspection certificate in each car, mounted under acrylic cover with frame made from satin stainless steel, No. 4 finish.
- b. Provide hooks for protective pads and one complete set of full-height protective pads.

2.4 SYSTEMS AND COMPONENTS

- A. Pump Units: Positive-displacement type with a maximum of 10 percent variation between no load and full load and with minimum pulsations.
 1. Pump shall be submersible type with submersible squirrel-cage induction motor, and shall be suspended inside oil tank from vibration isolation mounts or shall be tank-top-mounted type with fan-cooled, squirrel-cage induction motor, and shall be mounted on oil tank with vibration isolation mounts and enclosed in prime-painted steel enclosure lined with 1-inch-thick, glass-fiber insulation board.
 2. Motor shall have variable-voltage, variable-frequency control.
- B. Hydraulic Silencers: System shall have hydraulic silencer containing pulsation-absorbing material in blowout-proof housing at pump unit.
- C. Piping: Size, type, and weight of piping as recommended by elevator manufacturer, with flexible connectors to minimize sound and vibration transmissions from power unit.
- D. Hydraulic Fluid: Elevator manufacturer's standard fire-resistant fluid with additives as needed to prevent oxidation of fluid, corrosion of cylinder and other components, and other adverse effects.
- E. Inserts: Furnish required concrete and masonry inserts and similar anchorage devices for installing guide rails, machinery, and other components of elevator work. Device installation is specified in another Section.
- F. Car Frame and Platform: Welded steel units.
- G. Guides: Roller guides. Provide guides at top and bottom of car frame.

2.5 OPERATION SYSTEMS

- A. General: Provide manufacturer's standard microprocessor operation system as required to provide type of operation indicated.
- B. Auxiliary Operations:
 1. Single-Car Battery-Powered Lowering: When power fails, car is lowered to the lowest floor, opens its doors, and shuts down. System includes rechargeable battery and automatic recharging system.
 2. Automatic Operation of Lights and Fan: When elevator is stopped and unoccupied with doors closed, lighting, ventilation fan, and cab displays are de-energized after 5 minutes and are re-energized before car doors open.

- C. Security Features: Security features shall not affect emergency firefighters' service.
 - 1. Keyswitch Operation: Push buttons are activated and deactivated by security keyswitches at car-control stations and hall push-button stations. Key is removable only in deactivated position.

2.6 DOOR-REOPENING DEVICES

- A. Infrared Array: Provide door-reopening device with uniform array of 36 or more microprocessor-controlled, infrared light beams projecting across car entrance. Interruption of one or more light beams shall cause doors to stop and reopen.
- B. Nudging Feature: After car doors are prevented from closing for predetermined adjustable time, through activating door-reopening device, a loud buzzer shall sound and doors shall begin to close at reduced kinetic energy.

2.7 CAR ENCLOSURES

- A. General: Provide enameled- or powder-coated-steel car enclosures to receive removable wall panels, with car roof, access doors, power door operators, and ventilation.
 - 1. Provide standard railings complying with ASME A17.1/CSA B44 on car tops where required by ASME A17.1/CSA B44.
- B. Materials and Finishes: Manufacturer's standards, but not less than the following:
 - 1. Subfloor: Exterior, underlayment-grade plywood, not less than 5/8-inch nominal thickness.
 - 2. Floor Finish: Specified in Section 096543 "Linoleum Flooring."
 - 3. Stainless-Steel Wall Panels: Flush, formed-metal construction; fabricated from stainless-steel sheet.
 - 4. Plastic-Laminate Wall Panels: Plastic laminate adhesively applied to manufacturer's standard honeycomb core or manufacturer's standard formed metal panels with plastic-laminate panel backing and manufacturer's standard protective edge trim. Panels have a flame-spread index of 25 or less, when tested according to ASTM E 84. Plastic-laminate color, texture, and pattern as selected by Architect from elevator manufacturer's full range.
 - 5. Fabricate car with recesses and cutouts for signal equipment.
 - 6. Fabricate car door frame integrally with front wall of car.
 - 7. Enameled- or Powder-Coated-Steel Doors: Flush, hollow-metal construction; fabricated from cold-rolled steel sheet. Provide with factory-applied enamel or powder-coat finish; colors as selected by Architect from manufacturer's full range.
 - 8. Sills: Extruded or machined metal, with grooved surface, 1/4 inch thick.
 - 9. Luminous Ceiling: Fluorescent light fixtures and ceiling panels of translucent acrylic or other permanent rigid plastic.
 - 10. Light Fixture Efficiency: Not less than 35 lumens/W.
 - 11. Ventilation Fan Efficiency: Not less than 3.0 cfm/W.

2.8 HOISTWAY ENTRANCES

- A. Hoistway Entrance Assemblies: Manufacturer's standard horizontal-sliding, door-and-frame hoistway entrances complete with track systems, hardware, sills, and accessories. Frame size and profile shall accommodate hoistway wall construction.
 - 1. Where gypsum board wall construction is indicated, frames shall be self-supporting with reinforced head sections.
- B. Fire-Rated Hoistway Entrance Assemblies: Door-and-frame assemblies shall comply with NFPA 80 and be listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction based on testing at as close-to-neutral pressure as possible according to NFPA 252 or UL 10B.
 - 1. Fire-Protection Rating: 1 hour.
- C. Materials and Fabrication: Manufacturer's standards, but not less than the following:
 - 1. Enameled- or Powder-Coated-Steel Frames: Formed from cold- or hot-rolled steel sheet. Provide with factory-applied enamel or powder-coat finish; colors as selected by Architect from manufacturer's full range.
 - 2. Enameled- or Powder-Coated-Steel Doors: Flush, hollow-metal construction; fabricated from cold-rolled steel sheet. Provide with factory-applied enamel or powder-coat finish; colors as selected by Architect from manufacturer's full range.
 - 3. Sills: Extruded or machined metal, with grooved surface, 1/4 inch thick.
 - 4. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M.

2.9 SIGNAL EQUIPMENT

- A. General: Provide hall-call and car-call buttons that light when activated and remain lit until call has been fulfilled. Provide vandal-resistant buttons and lighted elements illuminated with LEDs.
- B. Car-Control Stations: Provide manufacturer's standard recessed car-control stations. Mount in return panel adjacent to car door unless otherwise indicated.
 - 1. Mark buttons and switches for required use or function. Use both tactile symbols and Braille.
 - 2. Provide "No Smoking" sign matching car-control station, either integral with car-control station or mounted adjacent to it, with text and graphics as required by authorities having jurisdiction.
- C. Emergency Communication System: Two-way voice communication system, with visible signal, which dials preprogrammed number of monitoring station and does not require handset use. System is contained in flush-mounted cabinet, with identification, instructions for use, and battery backup power supply.
- D. Car Position Indicator: Provide illuminated, digital-type car position indicator, located above car door or above car-control station. Also, provide audible signal to indicate to passengers that

car is either stopping at or passing each of the floors served. Include travel direction arrows if not provided in car-control station.

- E. Hall Push-Button Stations: Provide one hall push-button station at each landing.
 - 1. Provide manufacturer's standard wall-mounted units.
 - 2. Equip units with buttons for calling elevator and for indicating applicable direction of travel.
- F. Hall Lanterns: Units with illuminated arrows; however, provide single arrow at terminal landings. Provide the following:
 - 1. Manufacturer's standard wall-mounted units, for mounting above entrance frames.
- G. Hall Annunciator: With each hall lantern, provide audible signals indicating car arrival and direction of travel. Signals sound once for up and twice for down.
 - 1. At manufacturer's option, audible signals may be placed on cars.
- H. Standby-Power Elevator Selector Switches: Provide switches, as required by ASME A17.1/CSA B44, where indicated. Adjacent to switches, provide illuminated signal that indicates when normal power supply has failed.
- I. Fire-Command-Center Annunciator Panel: Provide panel containing illuminated position indicators for each elevator, clearly labeled with elevator designation; include illuminated signal that indicates when elevator is operational and when it is at the designated emergency return level with doors open. Provide standby-power elevator selector switch(es), as required by ASME A17.1/CSA B44, adjacent to position indicators. Provide illuminated signal that indicates when normal power supply has failed.
- J. Emergency Pictorial Signs: Fabricate from materials matching hall push-button stations, with text and graphics as required by authorities having jurisdiction, indicating that in case of fire, elevators are out of service and exits should be used instead. Provide one sign at each hall push-button station unless otherwise indicated.

2.10 FINISH MATERIALS

- A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, commercial steel, Type B, exposed, matte finish.
- B. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, commercial steel, Type B, pickled.
- C. Stainless-Steel Sheet: ASTM A 240/A 240M, Type 304.
- D. Stainless-Steel Bars: ASTM A 276, Type 304.
- E. Stainless-Steel Tubing: ASTM A 554, Grade MT 304.
- F. Aluminum Extrusions: ASTM B 221, Alloy 6063.

- G. Plastic Laminate: High-pressure type complying with NEMA LD 3, Type HGS for flat applications.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elevator areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work. Verify critical dimensions and examine supporting structure and other conditions under which elevator work is to be installed.
- B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install cylinder plumb and accurately centered for elevator car position and travel. Anchor securely in place, supported at pit floor and braced at intervals as needed to maintain alignment. Anchor cylinder guides at spacing needed to maintain alignment and avoid overstressing guides.
- B. Welded Construction: Provide welded connections for installing elevator work where bolted connections are not required for subsequent removal or for normal operation, adjustment, inspection, maintenance, and replacement of worn parts. Comply with AWS workmanship and welding operator qualification standards.
- C. Sound Isolation: Mount rotating and vibrating equipment on vibration-isolating mounts to minimize vibration transmission to structure and structure-borne noise due to elevator system.
- D. Install piping above the floor, where possible. Install underground piping in casing.
 - 1. Excavate for piping and backfill encased piping according to applicable requirements in Section 312000 "Earth Moving."
- E. Lubricate operating parts of systems as recommended by manufacturers.
- F. Alignment: Coordinate installation of hoistway entrances with installation of elevator guide rails for accurate alignment of entrances with car. Where possible, delay installation of sills and frames until car is operable in shaft. Reduce clearances to minimum, safe, workable dimension at each landing.
- G. Leveling Tolerance: 1/4 inch, up or down, regardless of load and travel direction.
- H. Set sills flush with finished floor surface at landing. Fill space under sill solidly with nonshrink, nonmetallic grout.

- I. Locate hall signal equipment for elevators as follows unless otherwise indicated:
 - 1. For groups of elevators, locate hall push-button stations between two elevators at center of group or at location most convenient for approaching passengers.
 - 2. Place hall lanterns either above or beside each hoistway entrance.
 - 3. Mount hall lanterns at a minimum of 72 inches above finished floor.

3.3 FIELD QUALITY CONTROL

- A. Acceptance Testing: On completion of elevator installation and before permitting elevator use (either temporary or permanent), perform acceptance tests as required and recommended by ASME A17.1/CSA B44 and by governing regulations and agencies.
- B. Advise Owner, Architect, and authorities having jurisdiction in advance of dates and times that tests are to be performed on elevators.

3.4 PROTECTION

- A. Temporary Use: Temporary use of elevator during construction is not permitted.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to operate elevator(s).
- B. Check operation of elevator with Owner's personnel present before date of Substantial Completion and again not more than one month before end of warranty period. Determine that operation systems and devices are functioning properly.

3.6 MAINTENANCE

- A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of elevator Installer. Include monthly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper elevator operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
 - 1. Perform maintenance during normal working hours.
 - 2. Perform emergency callback service during normal working hours with response time of two hours or less.

END OF SECTION

SECTION 210517 - SLEEVES AND SLEEVE SEALS FOR FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Sleeves.
 - 2. Sleeve-seal systems.
 - 3. Grout.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.
- C. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

2.2 SLEEVE-SEAL SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. Advance Products & Systems, Inc.
 - 2. CALPICO, Inc.
 - 3. Metraflex Company (The).

4. Pipeline Seal and Insulator, Inc.
5. [Proco Products, Inc.](#)

B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

1. Sealing Elements: EPDM-rubber or NBR interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Carbon steel or stainless steel.
3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, or stainless steel of length required to secure pressure plates to sealing elements.

2.3 GROUT

- A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.
 1. Sleeves are not required for core-drilled holes.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
 1. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
 2. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.
 3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 079200 "Joint Sealants."

- D. Install sleeves for pipes passing through interior partitions.
 - 1. Extend sleeves installed in concealed interior partitions a minimum of 1-inch beyond finished wall surface
 - 2. Cut sleeves to length in exposed locations to mount flush with finished surface where escutcheons are required.
 - 3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 - 4. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 079200 "Joint Sealants."
- E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.3 SLEEVE AND SLEEVE-SEAL SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
 - 1. Exterior Concrete Walls above Grade:
 - a. Piping Smaller Than NPS 6: Cast-iron wall sleeves with sleeve-seal system.
 - b. Piping NPS 6 and Larger: Cast-iron wall sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - 2. Exterior Concrete Walls below Grade:
 - a. Piping Smaller Than NPS 6: Cast-iron wall sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - b. Piping NPS 6 and Larger: Cast-iron wall sleeves with sleeve-seal system.

- 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
3. Concrete Slabs-on-Grade:
 - a. Piping Smaller Than NPS 6: Cast-iron wall sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - b. Piping NPS 6 and Larger: Cast-iron wall sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
4. Concrete Slabs above Grade:
 - a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
 - b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves.
5. Interior Partitions:
 - a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
 - b. Piping NPS 6 and Larger: Galvanized-steel-sheet sleeves.

END OF SECTION

SECTION 210518 - ESCUTCHEONS FOR FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Escutcheons.

1.3 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Product Data: For each type of product indicated. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

- A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
- C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.
- D. Split-Casting Brass Type: With polished, chrome-plated finish and with concealed hinge and setscrew.
- E. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed and exposed-rivet hinge, and spring-clip fasteners.

PART 3 - EXECUTION

3.1 INSTALLATION

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

3.2 FIELD QUALITY CONTROL

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

END OF SECTION

SECTION 210523 - GENERAL-DUTY VALVES FOR WATER-BASED FIRE-SUPPRESSION
PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Two-piece ball valves with indicators.
 - 2. Bronze butterfly valves with indicators.
 - 3. Iron butterfly valves with indicators.
 - 4. Check valves.
 - 5. Bronze OS&Y gate valves.
 - 6. Iron OS&Y gate valves.
 - 7. Trim and drain valves.

1.3 DEFINITIONS

- A. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
- B. NRS: Nonrising stem.
- C. OS&Y: Outside screw and yoke.
- D. SBR: Styrene-butadiene rubber.

1.4 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Product Data: For each type of valve. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:

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1. Protect internal parts against rust and corrosion.
 2. Protect threads, flange faces, and weld ends.
 3. Set valves open to minimize exposure of functional surfaces.
- B. Use the following precautions during storage:
1. Maintain valve end protection.
 2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems as lifting or rigging points.
- D. Protect flanges and specialties from moisture and dirt.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

- A. UL Listed: Valves shall be listed in UL's "Online Certifications Directory" and shall bear UL mark.
- B. FM Global Approved: Valves shall be listed in its "Approval Guide."
- C. Source Limitations for Valves: Obtain valves for each valve type from single manufacturer.
- D. ASME Compliance:
1. ASME B16.1 for flanges on iron valves.
 2. ASME B1.20.1 for threads for threaded-end valves.
 3. ASME B31.9 for building services piping valves.
- E. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.
- F. NFPA Compliance: Comply with NFPA 24 for valves.
- G. Valve Pressure Ratings: Not less than the minimum pressure rating indicated or higher as required by system pressures.
- H. Valve Sizes: Same as upstream piping unless otherwise indicated.
- I. Valve Actuator Types:
1. Worm-gear actuator with handwheel for quarter-turn valves, except for trim and drain valves.
 2. Handwheel: For other than quarter-turn trim and drain valves.
 3. Handlever: For quarter-turn trim and drain valves NPS 2 and smaller.

2.2 TWO-PIECE BALL VALVES WITH INDICATORS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. NIBCO INC.
 2. Victaulic Company.
- B. Description:
1. UL 1091, except with ball instead of disc and FM Global standard for indicating valves (butterfly or ball type), Class Number 1112.
 2. Minimum Pressure Rating: 175 psig.
 3. Body Design: Two piece.
 4. Body Material: Forged brass or bronze.
 5. Port Size: Full or standard.
 6. Seats: PTFE.
 7. Stem: Bronze or stainless steel.
 8. Ball: Chrome-plated brass.
 9. Actuator: Worm gear or traveling nut.
 10. Supervisory Switch: Internal or external.
 11. End Connections for Valves NPS 1 through NPS 2: Threaded ends.
 12. End Connections for Valves NPS 2-1/2: Grooved ends.

2.3 BRONZE BUTTERFLY VALVES WITH INDICATORS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. Fivalco Inc.
 2. Globe Fire Sprinkler Corporation.
 3. Milwaukee Valve Company.
- B. Description:
1. Standard: UL 1091 and FM Global standard for indicating valves, (butterfly or ball type), Class Number 1112.
 2. Minimum: Pressure rating: 175 psig.
 3. Body Material: Bronze.
 4. Seat Material: EPDM.
 5. Stem Material: Bronze or stainless steel.
 6. Disc: Bronze or stainless steel.
 7. Actuator: Worm gear or traveling nut.
 8. Supervisory Switch: Internal or external.
 9. Ends Connections for Valves NPS 1 through NPS 2: Threaded ends.
 10. Ends Connections for Valves NPS 2-1/2: Grooved ends.

2.4 IRON BUTTERFLY VALVES WITH INDICATORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Anvil International.
2. Fivalco Inc.
3. Globe Fire Sprinkler Corporation.
4. Kennedy Valve Company; a division of McWane, Inc.
5. NIBCO INC.
6. Tyco Fire Products LP.
7. Victaulic Company.
8. Zurn Industries, LLC.

B. Description:

1. Standard: UL 1091 and FM Global standard for indicating valves, (butterfly or ball type), Class Number 112.
2. Minimum Pressure Rating: 175 psig.
3. Body Material: Cast or ductile iron.
4. Seat Material: EPDM.
5. Stem: Stainless steel.
6. Disc: Ductile iron, nickel plated and EPDM or SBR coated.
7. Actuator: Worm gear or traveling nut.
8. Supervisory Switch: Internal or external.
9. Body Design: Grooved-end connections.

2.5 CHECK VALVES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Anvil International.
2. Fivalco Inc.
3. Globe Fire Sprinkler Corporation.
4. Kennedy Valve Company; a division of McWane, Inc.
5. Mueller Co.
6. NIBCO INC.
7. Reliable Automatic Sprinkler Co., Inc. (The).
8. Tyco Fire Products LP.
9. United Brass Works, Inc.
10. Victaulic Company.
11. Viking Corporation.
12. Watts; a Watts Water Technologies company.
13. Zurn Industries, LLC.

B. Description:

1. Standard: UL 312 and FM Global standard for swing check valves, Class Number 1210.

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2. Minimum Pressure Rating: 175 psig.
3. Type: Single swing check.
4. Body Material: Cast iron, ductile iron, or bronze.
5. Clapper: Bronze, ductile iron, or stainless steel with elastomeric seal.
6. Clapper Seat: Brass, bronze, or stainless steel.
7. Hinge Shaft: Bronze or stainless steel.
8. Hinge Spring: Stainless steel.
9. End Connections: Flanged, grooved, or threaded.

2.6 BRONZE OS&Y GATE VALVES

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. [Milwaukee Valve Company.](#)
2. [NIBCO INC.](#)
3. [United Brass Works, Inc.](#)
4. [Zurn Industries, LLC.](#)

- B. Description:

1. Standard: UL 262 and FM Global standard for fire-service water control valves (OS&Y- and NRS-type gate valves).
2. Minimum Pressure Rating: 175 psig.
3. Body and Bonnet Material: Bronze or brass.
4. Wedge: One-piece bronze or brass.
5. Wedge Seat: Bronze.
6. Stem: Bronze or brass.
7. Packing: Non-asbestos PTFE.
8. Supervisory Switch: External.
9. End Connections: Threaded.

2.7 IRON OS&Y GATE VALVES

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. [Hammond Valve.](#)
2. [Kennedy Valve Company; a division of McWane, Inc.](#)
3. [Mueller Co.](#)
4. [NIBCO INC.](#)
5. [Victaulic Company.](#)
6. [Watts; a Watts Water Technologies company.](#)
7. [Zurn Industries, LLC.](#)

- B. Description:

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1. Standard: UL 262 and FM Global standard for fire-service water control valves (OS&Y- and NRS-type gate valves).
2. Minimum Pressure Rating: 175 psig.
3. Body and Bonnet Material: Cast or ductile iron.
4. Wedge: Cast or ductile iron, or bronze with elastomeric coating.
5. Wedge Seat: Cast or ductile iron, or bronze with elastomeric coating.
6. Stem: Brass or bronze.
7. Packing: Non-asbestos PTFE.
8. Supervisory Switch: External.
9. End Connections: Flanged or grooved.

2.8 TRIM AND DRAIN VALVES

A. Ball Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Apollo Valves; Conbraco Industries, Inc.](#)
 - b. [Fire Protection Products, Inc.](#)
 - c. [Jomar Valve.](#)
 - d. [Legend Valve & Fitting, Inc.](#)
 - e. [Milwaukee Valve Company.](#)
 - f. [NIBCO INC.](#)
 - g. [Potter Roemer LLC.](#)
 - h. [Red White Valve Corp.](#)
 - i. [Tyco Fire Products LP.](#)
 - j. [Victaulic Company.](#)
 - k. [Watts; a Watts Water Technologies company.](#)
 - l. [Zurn Industries, LLC.](#)
2. Description:
 - a. Pressure Rating: 175 psig.
 - b. Body Design: Two piece.
 - c. Body Material: Forged brass or bronze.
 - d. Port size: Full.
 - e. Seats: PTFE.
 - f. Stem: Bronze or stainless steel.
 - g. Ball: Chrome-plated brass.
 - h. Actuator: Handlever.
 - i. End Connections for Valves NPS 1 through NPS 2-1/2: Threaded ends.
 - j. End Connections for Valves NPS 1-1/4 and NPS 2-1/2: Grooved ends.

B. Globe Valves:

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1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. NIBCO INC.
 - b. United Brass Works, Inc.
2. Description:
 - a. Pressure Rating: 175 psig.
 - b. Body Material: Bronze with integral seat and screw-in bonnet.
 - c. Ends: Threaded.
 - d. Stem: Bronze.
 - e. Disc Holder and Nut: Bronze.
 - f. Disc Seat: Nitrile.
 - g. Packing: Asbestos free.
 - h. Handwheel: Malleable iron, bronze, or aluminum.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

3.2 GENERAL REQUIREMENTS FOR VALVE INSTALLATION

- A. Comply with requirements in the following Sections for specific valve installation requirements and applications:
 1. Section 211100 "Facility Fire-Suppression Water-Service Piping" for application of valves in fire-suppression water-service piping outside the building.
 2. Section 211313 "Wet-Pipe Sprinkler Systems" for application of valves in wet-pipe, fire-suppression sprinkler systems.

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- B. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.
- C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.
- D. Install valves having threaded connections with unions at each piece of equipment arranged to allow easy access, service, maintenance, and equipment removal without system shutdown. Provide separate support where necessary.
- E. Install valves in horizontal piping with stem at or above the pipe center.
- F. Install valves in position to allow full stem movement.
- G. Install valve tags. Comply with requirements in Section 210553 "Identification for Fire-Suppression Piping and Equipment" for valve tags and schedules and signs on surfaces concealing valves; and the NFPA standard applying to the piping system in which valves are installed. Install permanent identification signs indicating the portion of system controlled by each valve.

END OF SECTION

SECTION 210548 - VIBRATION AND SEISMIC CONTROLS FOR FIRE-SUPPRESSION PIPING
AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Elastomeric hangers.
 - 2. Restraint channel bracings.
 - 3. Seismic-restraint accessories.

1.3 DEFINITIONS

- A. IBC: International Building Code.
- B. ICC-ES: ICC-Evaluation Service.
- C. OSHPD: Office of Statewide Health Planning & Development (for the State of California).

1.4 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Product Data: For each type of product. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.
 - 1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
- C. Delegated-Design Submittal: For each vibration isolation and seismic-restraint device.
 - 1. Include design calculations and details for selecting vibration isolators and seismic restraints complying with performance requirements, design criteria, and analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 2. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, due to seismic forces required to select vibration isolators, and due to seismic restraints.

3. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system was examined for excessive stress and that none exists.
4. Seismic-Restraint Details:
 - a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
 - b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
 - c. Preapproval and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

1.5 INFORMATIONAL SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Coordination Drawings: Show coordination of vibration isolation device installation and seismic bracing for fire-suppression piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.
- C. Qualification Data: For professional engineer.
- D. Welding certificates.
- E. Field quality-control reports.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7 and that is acceptable to authorities having jurisdiction.
- B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
- C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on

calculations. If preapproved ratings are unavailable, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic-Restraint Loading:

1. Site Class as Defined in the IBC: E.
2. Assigned Seismic Use Group or Building Category as Defined in the IBC: III.
 - a. Component Importance Factor: 1.5.
 - b. Component Response Modification Factor: 3.5.
 - c. Component Amplification Factor: 2.5.
3. Design Spectral Response Acceleration at Short Periods (0.2 Second): 0.32.
4. Design Spectral Response Acceleration at 1.0-Second Period: 0.08.

2.2 ELASTOMERIC HANGERS

A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods:

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [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.

2.3 RESTRAINT CHANNEL BRACINGS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. B-line, an Eaton business.
 2. Hilti, Inc.
 3. Mason Industries, Inc.
 4. Unistrut; Part of Atkore International.
- 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.

2.4 SEISMIC-RESTRAINT ACCESSORIES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. B-line, an Eaton business.
 2. Kinetics Noise Control, Inc.
 3. Mason Industries, Inc.
 4. Novia; A Division of C&P.
 5. TOLCO.
 6. Vibration & Seismic Technologies, LLC.
- B. Hanger-Rod Stiffener: Reinforcing steel angle clamped to hanger rod.
- C. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings.
- D. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation and seismic-control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.
- B. Hanger-Rod Stiffeners: Install hanger-rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.
- C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength is adequate to carry present and future static and seismic loads within specified loading limits.

3.3 VIBRATION CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

- A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033053 "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. Equipment Restraints:
 - 1. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
 - 2. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.
- D. Piping Restraints:
 - 1. Comply with requirements in MSS SP-127 and NFPA 13.
 - 2. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
 - 3. Brace a change of direction longer than 12 feet.
- E. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.
- F. 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.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Section 211313 "Wet-Pipe Sprinkler Systems" for piping flexible connections.

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END OF SECTION

SECTION 210553 - IDENTIFICATION FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

1.3 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Product Data: For each type of product. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.
- C. Equipment-Label Schedule: Include a listing of all equipment to be labeled and the proposed content for each label.
- D. Valve Schedules: Valve numbering scheme.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

- A. Plastic Labels for Equipment:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Brady Corporation.
 - b. Brimar Industries, Inc.

- c. [Carlton Industries, LP.](#)
 - d. [Champion America.](#)
 - e. [Craftmark Pipe Markers.](#)
 - f. [emedco.](#)
 - g. [Kolbi Pipe Marker Co.](#)
 - h. [LEM Products Inc.](#)
 - i. [Marking Services, Inc.](#)
 - j. [Seton Identification Products.](#)
2. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, with predrilled holes for attachment hardware.
 3. Letter Color: White.
 4. Background Color: Black.
 5. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
 6. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 7. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 8. Fasteners: Stainless-steel rivets or self-tapping screws.
 9. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

2.2 WARNING SIGNS AND LABELS

- A. [Manufacturers:](#) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 1. [Brady Corporation.](#)
 2. [Brimar Industries, Inc.](#)
 3. [Carlton Industries, LP.](#)
 4. [Champion America.](#)
 5. [Craftmark Pipe Markers.](#)
 6. [emedco.](#)
 7. [LEM Products Inc.](#)
 8. [Marking Services Inc.](#)
 9. [National Marker Company.](#)
 10. [Seton Identification Products.](#)
 11. [Stranco, Inc.](#)
- B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, with predrilled holes for attachment hardware.
- C. Letter Color: White.
- D. Background Color: Red.
- E. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

- F. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- G. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- H. Fasteners: Stainless-steel rivets or self-tapping screws.
- I. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- J. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. Actioncraft Products, Inc.; a division of Industrial Test Equipment Co., Inc.
 - 2. Brady Corporation.
 - 3. Brimar Industries, Inc.
 - 4. Carlton Industries, LP.
 - 5. Champion America.
 - 6. Craftmark Pipe Markers.
 - 7. emedco.
 - 8. Kolbi Pipe Marker Co.
 - 9. LEM Products Inc.
 - 10. Marking Services Inc.
 - 11. Seton Identification Products.
- B. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service and showing flow direction according to ASME A13.1.
- C. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- D. Self-adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- E. Pipe-Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with piping-system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
 - 2. Lettering Size: At least 1/2 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances.
- F. Pipe-Label Colors:

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1. Background Color: Safety Red.
2. Letter Color: White.

2.4 VALVE TAGS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Actioncraft Products, Inc.; a division of Industrial Test Equipment Co., Inc.
2. Brady Corporation.
3. Brimar Industries, Inc.
4. Carlton Industries, LP.
5. Champion America.
6. Craftmark Pipe Markers.
7. emedco.
8. Kolbi Pipe Marker Co.
9. LEM Products Inc.
10. Marking Sevices Inc.
11. Seton Identification Products.

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

1. Tag Material: Brass, 0.032 inch thick, with predrilled holes for attachment hardware.
2. Fasteners: Brass wire-link chain, beaded chain or S-hook.
3. Valve-Tag Color: Safety Red.
4. Letter Color: White.

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

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

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of incompatible primers, paints, and encapsulants, as well as dirt, oil, grease, release agents, and other substances that could impair bond of identification devices.

3.2 GENERAL INSTALLATION REQUIREMENTS

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

3.3 EQUIPMENT LABEL INSTALLATION

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

3.4 PIPE LABEL INSTALLATION

- A. Piping: Painting of piping is specified in Section 099123 "Interior Painting."
- B. Pipe-Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve and control device.
 - 2. Near each branch connection excluding short takeoffs. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations and on both sides of through walls, floors, ceilings, and inaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit a view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
 - 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
- C. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes including pipes where flow is allowed in both directions.

3.5 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in fire-suppression piping systems. List tagged valves in a valve-tag schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and with captions similar to those indicated in "Valve-Tag Size and Shape" Subparagraph below:
 - 1. Valve-Tag Size and Shape: 1-1/2 inches, round.

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END OF SECTION

SECTION 211119 - FIRE-DEPARTMENT CONNECTIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Exposed-type fire-department connections.

1.3 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Product Data: For each type of product. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each fire-department connection.

PART 2 - PRODUCTS

2.1 EXPOSED-TYPE FIRE-DEPARTMENT CONNECTION

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. [Elkhart Brass Mfg. Co., Inc.](#)
 - 2. [Fire Protection Products, Inc.](#)
 - 3. [Guardian Fire Equipment, Inc.](#)
 - 4. Tyco Fire & Building Products LP.
- B. Standard: UL 405.
- C. Type: Exposed, projecting, for wall mounting with one 4-inch Storz inlet with 30 degrees down elbow, inlet screen and round escutcheon plate.
- D. Pressure Rating: 175 psig minimum.

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- E. Body Material: Corrosion-resistant metal.
- F. Inlets: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
- G. Caps: Brass, lugged type, with gasket and chain.
- H. Escutcheon Plate: Round, brass, wall type.
- I. Outlet: Back, with pipe threads.
- J. Number of Inlets: One.
- K. Escutcheon Plate Marking: Similar to "AUTO SPKR."
- L. Finish: Polished chrome plated.
- M. Outlet Size: NPS 4.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of fire-department connections.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install wall-type fire-department connections.
- B. Install automatic (ball-drip) drain valve at each check valve for fire-department connection.

END OF SECTION

SECTION 211313 - WET-PIPE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Pipes, fittings, and specialties.
2. Specialty valves.
3. Backflow preventers.
4. Sprinklers.
5. Alarm devices.
6. Pressure gages.
7. Flexible connectors.

B. Related Requirements:

1. Section 211119 "Fire Department Connections" for exposed-type fire department connections.
2. Section 230523 "General-Duty Valves for Water-Based Fire-Suppression Piping" for ball, butterfly, check, gate, and trim and drain valves.

1.3 DEFINITIONS

- A. Standard-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure of 175-psig maximum.

1.4 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.

- B. Product Data: For each type of product. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

- C. Sustainable Design Submittals:

1. **Product Data:** For adhesives, indicating VOC content.
 2. **Laboratory Test Reports:** For adhesives, indicating compliance with requirements for low-emitting materials.
- D. **Shop Drawings:** For wet-pipe sprinkler systems.
1. Include plans, elevations, sections, and attachment details.
 2. Include diagrams for power, signal, and control wiring.
- E. **Delegated-Design Submittal:** For wet-pipe sprinkler systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. **Coordination Drawings:** Sprinkler systems, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Domestic water piping.
 2. HVAC hydronic piping and ductwork.
 3. Items penetrating finished ceiling include the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Access panels.
- C. **Qualification Data:** For qualified Installer and professional engineer.
- D. **Approved Sprinkler Piping Drawings:** Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.
- E. **Welding certificates.**
- F. **Fire-hydrant flow test report.**
- G. **Field Test Reports and Certificates:** Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."
- H. **Field quality-control reports.**

1.6 CLOSEOUT SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Operation and Maintenance Data: For wet-pipe sprinkler systems and specialties to include in emergency, operation, and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler used on Project.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
 - a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.
- B. Welding Qualifications: Qualify procedures and operators according to 2010 ASME Boiler and Pressure Vessel Code.

1.9 FIELD CONDITIONS

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:
 - 1. NFPA 13.

- B. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.
- C. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design wet-pipe sprinkler systems.
 - 1. Sprinkler system design shall be approved by authorities having jurisdiction.
 - a. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
 - b. Sprinkler Occupancy Hazard Classifications:
 - 1) Building Service Areas: Ordinary Hazard, Group 1.
 - 2) Electrical Equipment Rooms: Ordinary Hazard, Group 1.
 - 3) General Storage Areas: Ordinary Hazard, Group 1.
 - 4) Mechanical Equipment Rooms: Ordinary Hazard, Group 1.
 - 5) Office and Public Areas: Light Hazard.
 - 2. Minimum Density for Automatic-Sprinkler Piping Design:
 - a. Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. area.
 - b. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft. area.
 - c. Ordinary-Hazard, Group 2 Occupancy: 0.20 gpm over 1500-sq. ft. area.
 - 3. Maximum Protection Area per Sprinkler: According to UL listing.
- D. Seismic Performance: Sprinkler piping shall withstand the effects of earthquake motions determined according to NFPA 13 and ASCE/SEI 7.

2.2 STEEL PIPE AND FITTINGS

- A. Schedule 40 Standard-Weight, Galvanized- and Black-Steel Pipe: ASTM A 53/A 53M, Grade B. Pipe ends may be factory or field formed to match joining method.
- B. Schedule 10, Black-Steel Pipe: ASTM A 135/A 135M or ASTM A 795/A 795M, Schedule 10 in NPS 5; and NFPA 13-specified wall thickness in NPS 6 to NPS 10, plain end.
- C. Galvanized- and Black-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, standard-weight, seamless steel pipe with threaded ends.
- D. Galvanized- and Uncoated-Steel Couplings: ASTM A 865/A 865M, threaded.
- E. Galvanized and Uncoated, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.
- F. Malleable- or Ductile-Iron Unions: UL 860.
- G. Cast-Iron Flanges: ASME 16.1, Class 125.
- H. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.

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1. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free.
 - a. Class 125 and Class 250, Cast-Iron, Flat-Face Flanges: Full-face gaskets.
 - b. Class 150 and Class 300, Ductile-Iron or -Steel, Raised-Face Flanges: Ring-type gaskets.
 2. Metal, Pipe-Flange Bolts and Nuts: Carbon steel unless otherwise indicated.
- I. Steel Welding Fittings: ASTM A 234/A 234M and ASME B16.9.
1. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- J. Grooved-Joint, Steel-Pipe Appurtenances:
1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Anvil International.](#)
 - b. [Corcoran Piping System Co.](#)
 - c. [National Fittings, Inc.](#)
 - d. [Shurjoint Piping Products USA Inc.](#)
 - e. [Smith-Cooper International.](#)
 - f. [Tyco Fire Products LP.](#)
 - g. [Victaulic Company.](#)
 2. Pressure Rating: 175-psig minimum.
 3. Galvanized or Uncoated Grooved-End Fittings for Steel Piping: ASTM A 47/A 47M, malleable-iron casting or ASTM A 536, ductile-iron casting, with dimensions matching steel pipe.
 4. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213 rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.

2.3 SPECIALTY VALVES

- A. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
- B. Pressure Rating:
 1. Standard-Pressure Piping Specialty Valves: 175-psig minimum.
- C. Body Material: Cast or ductile iron.
- D. Size: Same as connected piping.
- E. End Connections: Flanged or grooved.

F. Alarm Valves:

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Globe Fire Sprinkler Corporation.](#)
 - b. [Reliable Automatic Sprinkler Co., Inc. \(The\).](#)
 - c. [Tyco Fire Products LP.](#)
 - d. [Venus Fire Protection Ltd.](#)
 - e. [Victaulic Company.](#)
 - f. [Viking Corporation.](#)
2. Standard: UL 193.
3. Design: For horizontal or vertical installation.
4. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, and fill-line attachment with strainer.
5. Drip Cup Assembly: Pipe drain with check valve to main drain piping.
6. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

G. Automatic (Ball Drip) Drain Valves:

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Reliable Automatic Sprinkler Co., Inc. \(The\).](#)
 - b. [Tyco Fire Products LP.](#)
2. Standard: UL 1726.
3. Pressure Rating: 175-psig minimum.
4. Type: Automatic draining, ball check.
5. Size: NPS 3/4.
6. End Connections: Threaded.

2.4 BACKFLOW PREVENTERS

A. Double-Check, Backflow-Prevention Assemblies:

1. Available Manufacturers:
 - a. Ames Fire & Waterworks; a division of Watts Water Technologies, Inc.
 - b. Conbraco Industries, Inc.; Apollo Valves.
 - c. FEBCO; SPX Valves & Controls.
 - d. Flomatic Corporation.
 - e. Watts Water Technologies, Inc.
 - f. Zurn Plumbing Products Group; Wilkins Water Control Products Division.

2. Standard: ASSE 1015 or AWWA C510.
3. Operation: Continuous-pressure applications unless otherwise indicated.
4. Pressure Loss: 5 psig maximum, through middle one-third of flow range.
5. Body Material: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved or steel with interior lining complying with AWWA C550 or that is FDA approved for NPS 2-1/2 and larger.
6. End Connections: Flanged for NPS 2-1/2 and larger.
7. Configuration: Designed for horizontal, straight through flow.
8. Accessories: OS&Y gate valves with flanged ends on inlet and outlet of NPS 2-1/2 and larger.

2.5 SPRINKLER PIPING SPECIALTIES

A. Branch Outlet Fittings:

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Anvil International.](#)
 - b. [National Fittings, Inc.](#)
 - c. [Shurjoint Piping Products USA Inc.](#)
 - d. [Tyco Fire Products LP.](#)
 - e. [Victaulic Company.](#)
2. Standard: UL 213.
3. Pressure Rating: 175-psig minimum.
4. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
5. Type: Mechanical-tee and -cross fittings.
6. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
7. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
8. Branch Outlets: Grooved, plain-end pipe, or threaded.

B. Flow Detection and Test Assemblies:

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [AGF Manufacturing Inc.](#)
 - b. [Reliable Automatic Sprinkler Co., Inc. \(The\).](#)
 - c. [Tyco Fire Products LP.](#)
 - d. [Victaulic Company.](#)
2. Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
3. Pressure Rating: 175-psig minimum.
4. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.

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5. Size: Same as connected piping.
6. Inlet and Outlet: Threaded or grooved.

C. Branch Line Testers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Elkhart Brass Mfg. Co., Inc.
 - b. Fire-End & Croker Corporation.
 - c. Potter Roemer LLC.
2. Standard: UL 199.
3. Pressure Rating: 175 psig.
4. Body Material: Brass.
5. Size: Same as connected piping.
6. Inlet: Threaded.
7. Drain Outlet: Threaded and capped.
8. Branch Outlet: Threaded, for sprinkler.

D. Sprinkler Inspector's Test Fittings:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. AGF Manufacturing Inc.
 - b. Triple R Specialty.
 - c. Tyco Fire Products LP.
 - d. Victaulic Company.
 - e. Viking Corporation.
2. Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
3. Pressure Rating: 175-psig minimum.
4. Body Material: Cast- or ductile-iron housing with sight glass.
5. Size: Same as connected piping.
6. Inlet and Outlet: Threaded.

E. Adjustable Drop Nipples:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Aegis Technologies, Inc.
 - b. CECA, LLC.
 - c. Corcoran Piping System Co.
 - d. Merit Manufacturing.

2. Standard: UL 1474.
3. Pressure Rating: 250-psig minimum.
4. Body Material: Steel pipe with EPDM-rubber O-ring seals.
5. Size: Same as connected piping.
6. Length: Adjustable.
7. Inlet and Outlet: Threaded.

2.6 SPRINKLERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. Globe Fire Sprinkler Corporation.
 2. Reliable Automatic Sprinkler Co., Inc. (The).
 3. Tyco Fire Products LP.
 4. Venus Fire Protection Ltd.
 5. Victaulic Company.
 6. Viking Corporation.
- B. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
- C. Pressure Rating for Automatic Sprinklers: 175-psig minimum.
- D. Automatic Sprinklers with Heat-Responsive Element:
1. Nonresidential Applications: UL 199.
 2. Characteristics: Nominal 1/2-inch orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.
- E. Sprinkler Finishes: White painted, polished bronze, and rough bronze; as indicated on plans.
- F. Special Coatings: Wax and corrosion-resistant paint.
- G. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.
1. Ceiling Mounting: Plastic, white finish, one piece, flat.
 2. Sidewall Mounting: Plastic, white finish, one piece, flat.
- H. Sprinkler Guards:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Reliable Automatic Sprinkler Co., Inc. (The).
 - b. Tyco Fire Products LP.

- c. [Victaulic Company.](#)
 - d. [Viking Corporation.](#)
2. Standard: UL 199.
 3. Type: Wire cage with fastening device for attaching to sprinkler.

2.7 ALARM DEVICES

A. Alarm-device types shall match piping and equipment connections.

B. Electrically Operated Alarm Bell:

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Fire-Lite Alarms, Inc.; a Honeywell International company.](#)
 - b. [Notifier.](#)
 - c. [Potter Electric Signal Company, LLC.](#)
2. Standard: UL 464.
3. Type: Vibrating, metal alarm bell.
4. Size: 8-inch minimum-diameter.
5. Finish: Red-enamel factory finish, suitable for outdoor use.
6. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Water-Flow Indicators:

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [ADT Security Services, Inc.](#)
 - b. [McDonnell & Miller.](#)
 - c. [Potter Electric Signal Company, LLC.](#)
 - d. [System Sensor.](#)
 - e. [Viking Corporation.](#)
 - f. [Watts; a Watts Water Technologies company.](#)
2. Standard: UL 346.
3. Water-Flow Detector: Electrically supervised.
4. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
5. Type: Paddle operated.

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6. Pressure Rating: 250 psig.
7. Design Installation: Horizontal or vertical.

D. Valve Supervisory Switches:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Fire-Lite Alarms, Inc.; a Honeywell International company.
 - b. Kennedy Valve Company; a division of McWane, Inc.
 - c. Potter Electric Signal Company, LLC.
 - d. System Sensor.
2. Standard: UL 346.
3. Type: Electrically supervised.
4. Components: Single-pole, double-throw switch with normally closed contacts.
5. Design: Signals that controlled valve is in other than fully open position.
6. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.8 PRESSURE GAGES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. AGF Manufacturing Inc.
 2. AMETEK, Inc.
 3. Ashcroft Inc.
 4. Brecco Corporation.
 5. WIKA Instrument Corporation.
- B. Standard: UL 393.
- C. Dial Size: 3-1/2- to 4-1/2-inch diameter.
- D. Pressure Gage Range: 0- to 250-psig minimum.
- E. Label: Include "WATER" label on dial face.

2.9 FLEXIBLE CONNECTORS

- A. Flexible connectors shall have materials suitable for system fluid. Include 175-psig minimum working pressure rating and ends according to the following:
1. NPS 2 and Smaller: Threaded.
 2. NPS 2-1/2 and Larger: Flanged.

3. Option for NPS 2-1/2 and Larger: Grooved for use with grooved-end-pipe couplings.
- B. Flexible Expansion Loop: Prefabricated flexible loop with two sections of metal hose and braid connected with 180 degree return elbow and provided with two 90 degree elbows. Return elbow shall be provided with drain/air plug and center support nut.
 1. Available Manufacturers:
 - a. Flex-Hose Co., Inc.
 - b. Flexicraft Industries.
 - c. Metraflex Inc.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.
- B. Report test results promptly and in writing.

3.2 SERVICE-ENTRANCE PIPING

- A. Connect sprinkler piping to water-service piping for service entrance to building. Comply with requirements for exterior piping in Section 211100 "Facility Fire-Suppression Water-Service Piping" for exterior piping.
- B. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water-service piping.
- C. Install shutoff valve, check valve, pressure gage, and drain at connection to water service.

3.3 PIPING INSTALLATION

- A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated on approved working plans.
 1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
 2. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.
- B. Piping Standard: Comply with NFPA 13 requirements for installation of sprinkler piping.
- C. Install seismic restraints on piping. Comply with NFPA 13 requirements for seismic-restraint device materials and installation.

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- D. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- E. Install unions adjacent to each valve in pipes NPS 2 and smaller.
- F. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.
- G. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.
- H. Install sprinkler piping with drains for complete system drainage.
- I. Install automatic (ball drip) drain valve at each check valve for fire-department connection, to drain piping between fire-department connection and check valve. Install drain piping to and spill over floor drain or to outside building.
- J. Install alarm devices in piping systems.
- K. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13. In seismic-rated areas, refer to Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment."
- L. Install pressure gages on riser or feed main, and at each sprinkler test connection. Include pressure gages with connection not less than NPS 1/4 and with soft-metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they are not subject to freezing.
- M. Fill sprinkler system piping with water.
- N. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."
- O. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."
- P. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 210518 "Escutcheons for Fire-Suppression Piping."
- Q. Install flexible expansion loops where sprinkler piping crosses the building expansion point. Provide a vertical support hanger on each side of the flexible loop, with hanger braced transversely and longitudinally as required for seismic restraint.

3.4 JOINT CONSTRUCTION

- A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.
- B. Install unions adjacent to each valve in pipes NPS 2 and smaller.
- C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.
- D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.
- G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- H. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
 - 1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.
- I. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.
- J. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.
- K. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.5 VALVE AND SPECIALTIES INSTALLATION

- A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.

- B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.
- C. Install backflow preventer in each water-supply connection.
- D. Specialty Valves:
 - 1. Install valves in vertical position for proper direction of flow, in main supply to system.
 - 2. Install alarm valves with bypass check valve and retarding chamber drain-line connection.

3.6 SPRINKLER INSTALLATION

- A. Install sprinklers in suspended ceilings in center of narrow dimension of acoustical ceiling panels.
- B. Install dry-type sprinklers with water supply from heated space. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing.

3.7 IDENTIFICATION

- A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.
- B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.8 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - 3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
 - 4. Energize circuits to electrical equipment and devices.
 - 5. Coordinate with fire-alarm tests. Operate as required.
 - 6. Verify that equipment hose threads are same as local fire department equipment.
- B. Sprinkler piping system will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.9 CLEANING

- A. Clean dirt and debris from sprinklers.
- B. Only sprinklers with their original factory finish are acceptable. Remove and replace any sprinklers that are painted or have any other finish than their original factory finish.

3.10 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain specialty valves.

3.11 PIPING SCHEDULE

- A. Piping between Fire Department Connections and Check Valves: Galvanized Schedule 40, standard-weight steel pipe with threaded ends, cast-iron threaded fittings, and threaded or grooved ends, grooved-end fittings, grooved-end-pipe couplings, and grooved joints.
- B. Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.
- C. Standard-pressure, wet-pipe sprinkler system, NPS 2 and smaller, shall be one of the following:
 - 1. Schedule 40 Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
 - 2. Schedule 40 Standard-weight, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
 - 3. Schedule 40 Standard-weight, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
 - 4. Schedule 40 Standard-weight, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
 - 5. Schedule 40 Standard-weight, black-steel pipe with plain ends; steel welding fittings; and welded joints.
- D. Standard-pressure, wet-pipe sprinkler system, NPS 2-1/2 to NPS 4, shall be one of the following:
 - 1. Schedule 40 Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
 - 2. Schedule 40 Standard-weight, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
 - 3. Schedule 40 Standard-weight, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
 - 4. Schedule 40 Standard-weight, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

5. Schedule 40 Standard-weight, black-steel pipe with plain ends; steel welding fittings; and welded joints.

E. Standard-pressure, wet-pipe sprinkler system, NPS 5 and larger, shall be the following:

1. Schedule 40 Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
2. Schedule 40 Standard-weight, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
3. Schedule 40 Standard-weight, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
4. Schedule 40 Standard-weight, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
5. Schedule 40 Standard-weight, black-steel pipe with plain ends; steel welding fittings; and welded joints.
6. Schedule 10 black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

3.12 SPRINKLER SCHEDULE

A. Use sprinkler types in subparagraphs below for the following applications:

1. Rooms without Ceilings: Upright sprinklers.
2. Rooms with Suspended Ceilings: White recessed sprinklers. Provide concealed sprinklers as indicated.
3. Wall Mounting: Sidewall sprinklers.
4. Spaces Subject to Freezing: Upright, pendent, dry sprinklers; and sidewall, dry sprinklers as indicated.
5. Special Applications: Extended-coverage, flow-control, and quick-response sprinklers where indicated.

B. Provide sprinkler types in subparagraphs below with finishes indicated.

1. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.
2. Recessed Sprinklers: White finish with painted white escutcheon.
3. Upright Pendent and Sidewall Sprinklers: White in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes.
 - a. In stage areas indicted on drawings, provide sprinkler heads with factory-painted black finish.
4. Flush Sprinklers: White painted, with painted white escutcheon.

END OF SECTION

SECTION 220517 - SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Sleeves.
 - 2. Sleeve-seal systems.
 - 3. Grout.

1.3 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of the Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Product Data: For each type of product indicated. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.
- C. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

2.2 SLEEVE-SEAL SYSTEMS

- A. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

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1. Sealing Elements: EPDM-rubber or NBR interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Carbon steel or stainless steel.
3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.3 GROUT

- A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.
 1. Sleeves are not required for core-drilled holes through walls.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
 1. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 4 inches above finished floor level.
 2. Using grout, seal the space outside of sleeves in slabs and walls.
- D. Install sleeves for pipes passing through interior partitions.
 1. Cut sleeves to length for mounting flush with both surfaces.
 2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 079200 "Joint Sealants."

- E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.3 SLEEVE AND SLEEVE-SEAL SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
 - 1. Exterior Concrete Walls above Grade:
 - a. Galvanized-steel-pipe sleeves.
 - 2. Exterior Concrete Walls below Grade:
 - a. Cast-iron wall sleeves with sleeve-seal system or Galvanized-steel-pipe sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - 3. Concrete Slabs-on-Grade:
 - a. Galvanized-steel-pipe sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - 4. Concrete Slabs above Grade:
 - a. Galvanized-steel-pipe sleeves.
 - 5. Interior Partitions:
 - a. Piping Smaller than NPS 6: Galvanized-steel-pipe sleeves.
 - b. Piping NPS 6 and Larger: Galvanized-steel-sheet sleeves.

END OF SECTION

SECTION 220518 - ESCUTCHEONS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Escutcheons.
 - 2. Floor plates.

1.3 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of the Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Product Data: For each type of product indicated. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

- A. One-Piece, Cast-Brass Type: With polished, chrome-plated and rough-brass finish and setscrew fastener.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.

2.2 FLOOR PLATES

- A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.

PART 3 - EXECUTION

3.1 INSTALLATION

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

3.2 FIELD QUALITY CONTROL

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

END OF SECTION

SECTION 220519 - METERS AND GAGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Liquid-in-glass thermometers.
2. Thermowells.
3. Dial-type pressure gages.
4. Gage attachments.

B. Related Requirements:

1. Section 221119 "Domestic Water Piping Specialties" for water meters by the municipal water supplier.

1.3 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of the Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Product Data: For each type of product. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.

1.4 INFORMATIONAL SUBMITTALS

- A. Submittals shall comply with the requirements of the Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Product Certificates: For each type of meter and gage.

1.5 CLOSEOUT SUBMITTALS

- A. Submittals shall comply with the requirements of the Section 013300 "Submittal Procedures" and the individual sections specifying the work.

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

PART 2 - PRODUCTS

2.1 LIQUID-IN-GLASS THERMOMETERS

A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:

1. Standard: ASME B40.200.
2. Case: Cast aluminum; 7-inch nominal size unless otherwise indicated.
3. Case Form: Adjustable angle unless otherwise indicated.
4. Tube: Glass with magnifying lens and blue or red organic liquid.
5. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
6. Window: Glass.
7. Stem: Aluminum and of length to suit installation.
 - a. Design for Thermowell Installation: Bare stem.
8. Connector: 1-1/4 inches, with ASME B1.1 screw threads.
9. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.2 THERMOWELLS

A. Thermowells:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. Type: Stepped shank unless straight or tapered shank is indicated.
4. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
5. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
6. Bore: Diameter required to match thermometer bulb or stem.
7. Insertion Length: Length required to match thermometer bulb or stem.
8. Lagging Extension: Include on thermowells for insulated piping and tubing.
9. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

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

2.3 PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Standard: ASME B40.100.

2. Case: Liquid-filled, sealed type(s); cast aluminum or drawn steel; 2-1/2-inch nominal diameter.
3. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
4. Pressure Connection: Brass, with ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
5. Movement: Mechanical, with link to pressure element and connection to pointer.
6. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
7. Pointer: Dark-colored metal.
8. Window: Glass.
9. Ring: Metal.
10. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.4 GAGE ATTACHMENTS

- A. Snubbers: ASME B40.100, brass; with ASME B1.20.1 pipe threads and piston or porous-metal-type surge-dampening device. Include extension for use on insulated piping.
- B. Valves: Brass or stainless-steel needle, with ASME B1.20.1 pipe threads.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install thermowells with socket extending one-third of pipe diameter and in vertical position in piping tees.
- B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
- C. Install thermowells with extension on insulated piping.
- D. Fill thermowells with heat-transfer medium.
- E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
- F. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
- G. Install valve and snubber in piping for each pressure gage.
- H. Install thermometers in the following locations:
 1. Inlet and outlet of each water heater.
- I. Install pressure gages in the following locations:
 1. Building water service entrance into building.

3.2 CONNECTIONS

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

3.3 ADJUSTING

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

3.4 THERMOMETER SCHEDULE

- A. Thermometers at inlet and outlet of each domestic water heater shall be the following:
 - 1. Metal case, industrial-style, liquid-in-glass type.
- B. Thermometer stems shall be of length to match thermowell insertion length.

3.5 THERMOMETER SCALE-RANGE SCHEDULE

- A. Scale Range for Domestic Cold-Water Piping: 0 to 100 deg F.
- B. Scale Range for Domestic Hot-Water Piping: 30 to 240 deg F.

3.6 PRESSURE-GAGE SCHEDULE

- A. Pressure gages at discharge of each water service into building shall be the following:
 - 1. Liquid-filled, sealed, direct-mounted, metal case.

3.7 PRESSURE-GAGE SCALE-RANGE SCHEDULE

- A. Scale Range for Water Service Piping: 0 to 160 psi.

END OF SECTION

SECTION 220523.12 - BALL VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Bronze ball valves.

1.3 DEFINITIONS

- A. CWP: Cold working pressure.

1.4 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of the Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Product Data: For each type of valve. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.
 - 1. Certification that products comply with NSF 61 Annex G and NSF 372.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against corrosion.
 - 2. Protect threads and flange faces.
 - 3. Set ball valves open to minimize exposure of functional surfaces.
- B. Use the following precautions during storage:
 - 1. Maintain valve end protection.
 - 2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:
 - 1. ASME B1.20.1 for threads for threaded end valves.
- C. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.
- D. NSF Compliance: NSF 61 Annex G and NSF 372 for valve materials for potable-water service.
- E. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- F. Valve Sizes: Same as upstream piping unless otherwise indicated.
- G. Valve Actuator Types:
 - 1. Handlever: For quarter-turn valves smaller than NPS 4.
- H. Valves in Insulated Piping:
 - 1. Include 2-inch stem extensions.
 - 2. Extended operating handles of nonthermal-conductive material and protective sleeves that allow operation of valves without breaking vapor seals or disturbing insulation.
 - 3. Memory stops that are fully adjustable after insulation is applied.

2.2 BRONZE BALL VALVES

- A. Bronze Ball Valves, Two-Piece with Full Port and Stainless-Steel Trim:
 - 1. Description:
 - a. Standard: MSS SP-110.
 - b. CWP Rating: 600 psig.
 - c. Body Design: Two piece.
 - d. Body Material: Bronze.
 - e. Ends: Threaded.
 - f. Seats: PTFE.
 - g. Stem: Brass.

- h. Ball: Stainless-steel.
- i. Port: Full.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install valve tags. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

3.3 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.
- B. Select valves with the following end connections:
 - 1. For Copper Tubing, NPS 2 and Smaller: Threaded ends.
 - 2. For Copper Tubing, NPS 2-1/2 to NPS 3: Flanged ends except where threaded valve-end option is indicated in valve schedules below.

3.4 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

- A. Pipe NPS 2 and Smaller:
 - 1. Bronze ball valves, two-piece with full port, stainless-steel trim, and threaded ends.

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B. Pipe NPS 2-1/2 to NPS 3:

1. Bronze ball valves, two-piece with full port, stainless-steel trim, and threaded or flanged ends.

END OF SECTION

SECTION 220523.13 - BUTTERFLY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Iron, single-flange butterfly valves.

1.3 DEFINITIONS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene-diene terpolymer rubber.
- C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

1.4 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Product Data: For each type of valve.
 - 1. Certification that products comply with NSF 61 Annex G and NSF 372.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect flange faces.
 - 3. Set butterfly valves closed or slightly open.
- 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.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:
 1. ASME B16.1 for flanges on iron valves.
 2. ASME B16.5 for flanges on steel valves.
 3. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
 4. ASME B31.9 for building service piping valves.
- C. NSF Compliance: NSF 61 Annex G and NSF 372 for valve materials for potable-water service.
- D. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- E. Valve Sizes: Same as upstream piping unless otherwise indicated.
- F. Valve Actuator Types:
 1. Handlever: For valves NPS 6 and smaller.
- G. Valves in Insulated Piping: With 2-inch stem extensions.

2.2 IRON, SINGLE-FLANGE BUTTERFLY VALVES

- A. Iron, Single-Flange Butterfly Valves with Aluminum-Bronze Disc:
 1. Description:
 - a. Standard: MSS SP-67, Type I.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
 - e. Seat: EPDM.
 - f. Stem: One- or two-piece stainless steel.
 - g. Disc: Aluminum bronze.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine mating flange faces for damage. 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.
- D. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install valve tags. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

3.3 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

- A. Pipe NPS 4 and Larger:
 - 1. Iron, Single-Flange Butterfly Valves: 200 CWP, EPDM seat, aluminum-bronze disc.

END OF SECTION

SECTION 220523.14 - CHECK VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Bronze swing check valves.

1.3 DEFINITIONS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene-diene terpolymer rubber.
- C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

1.4 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of the Construction Contract Clauses, Section 007213 "General Conditions" and the individual sections specifying the work.
- B. Product Data: For each type of valve. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads.
 - 3. Set 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.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:
 - 1. ASME B1.20.1 for threads for threaded end valves.
 - 2. ASME B31.9 for building services piping valves.
- C. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.
- D. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- E. Valve Sizes: Same as upstream piping unless otherwise indicated.

2.2 BRONZE SWING CHECK VALVES

- A. Bronze Swing Check Valves with Nonmetallic Disc, Class 125:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Crane; Crane Energy Flow Solutions.
 - b. Hammond Valve.
 - c. Milwaukee Valve Company.
 - d. NIBCO INC.
 - e. Watts; a Watts Water Technologies company.
 - 2. Description:
 - a. Standard: MSS SP-80, Type 4.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Horizontal flow.
 - d. Body Material: ASTM B 62, bronze.
 - e. Ends: Threaded or soldered. See valve schedule articles.
 - f. Disc: PTFE.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

- A. Locate valves for easy access and provide separate support where necessary.
- B. Install check valves for proper direction of flow and as follows:
 - 1. Swing Check Valves: In horizontal position with hinge pin level.

3.3 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valve applications are not indicated, use the following:
 - 1. Pump-Discharge Check Valves:
 - a. NPS 2 and Smaller: Bronze swing check valves with nonmetallic disc.
- B. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.
- C. End Connections:
 - 1. For Steel Piping, NPS 2 and Smaller: Threaded.

3.4 SANITARY WASTE AND STORM DRAINAGE VALVE SCHEDULE

- A. Pipe NPS 2 and Smaller: Bronze swing check valves, Class 125, nonmetallic disc with threaded end connections.

END OF SECTION

SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Metal framing systems.
4. Thermal-hanger shield inserts.
5. Fastener systems.
6. Pipe stands.
7. Pipe positioning systems.
8. Equipment supports.

B. Related Sections:

1. Section 055000 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.

1.3 DEFINITIONS

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

1.4 PERFORMANCE REQUIREMENTS

- A. 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.

1.5 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of the Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Product Data: For each type of product indicated. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.
- C. Shop Drawings: Show fabrication and installation details and include calculations for the following; include Product Data for components:
 - 1. Trapeze pipe hangers.
 - 2. Metal framing systems.
 - 3. Pipe stands.
 - 4. Equipment supports.

1.6 INFORMATIONAL SUBMITTALS

- A. Submittals shall comply with the requirements of the Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Welding certificates.

1.7 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.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

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

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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.

2.2 TRAPEZE PIPE HANGERS

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

2.3 METAL FRAMING SYSTEMS

- A. Metal Framing Systems:

1. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
2. Standard: MFMA-4.
3. Channels: Continuous slotted steel channel with inturred lips.
4. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
6. Metallic Coating: Galvanized.

2.4 THERMAL-HANGER SHIELD INSERTS

- A. Insulation-Insert Material for Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.
- B. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- C. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- D. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.5 FASTENER SYSTEMS

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

2.6 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: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
- C. High-Type, Single-Pipe Stand:
 - 1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
 - 2. Base: Plastic or stainless steel.
 - 3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
 - 4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.
- D. High-Type, Multiple-Pipe Stand:
 - 1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
 - 2. Bases: One or more; plastic.
 - 3. Vertical Members: Two or more protective-coated-steel channels.
 - 4. Horizontal Member: Protective-coated-steel channel.
 - 5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.
- E. Curb-Mounting-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.

2.7 PIPE POSITIONING SYSTEMS

- A. Description: IAPMO PS 42, positioning system of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

2.8 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.9 MISCELLANEOUS MATERIALS

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

- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
 - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
 - 2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.
- D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- E. Fastener System Installation:
 - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
 - 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- F. 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.
- G. Pipe Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.

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- H. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- I. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- J. 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.
- K. Install lateral bracing with pipe hangers and supports to prevent swaying.
- L. 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.
- M. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- N. 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.
- O. Insulated Piping:
 - 1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
 - 2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 3. Install MSS SP-58, Type 40, 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 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: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.
 - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.

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

3.2 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 2. Obtain fusion without undercut or overlap.
 3. Remove welding flux immediately.
 4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers, and metal framing systems and attachments for general service applications.
- F. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.
- G. Use padded hangers for piping that is subject to scratching.
- H. Use thermal-hanger shield inserts for insulated piping and tubing.
- I. 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 stationary pipes NPS 1/2 to NPS 30.
 - 2. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
 - 3. 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.
 - 4. 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.
 - 5. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
 - 6. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.
 - 7. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.
- J. 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.
- K. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 3. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
- L. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction, to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 10. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 11. 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.
- M. 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.
- N. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

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- O. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
- P. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.
- Q. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION

SECTION 220533 - HEAT TRACING FOR PLUMBING PIPING AND SNOW MELT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes plumbing piping heat tracing for freeze prevention, domestic hot-water-temperature maintenance, and snow and ice melting with the following electric heating cables:
 - 1. Self-regulating, parallel resistance.

1.3 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of the Construction Contract Clauses, Section 013000 "Submittal Procedures" and the individual sections specifying the work.
- B. Sustainable Design Requirements: Work included in this specification shall conform to the US Green Building Council LEED requirements listed in Section 018113.13 "Sustainable Design Requirements – LEED for New Construction and Major Renovations."
- C. Product Data: For each type of product. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.
 - 1. Include rated capacities, operating characteristics, and furnished specialties and accessories.
 - 2. Schedule heating capacity, length of cable, spacing, and electrical power requirement for each electric heating cable required.
- D. Shop Drawings: For electric heating cable.
 - 1. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Submittals shall comply with the requirements of the Construction Contract Clauses, Section 013000 "Submittal Procedures" and the individual sections specifying the work.
- B. Field quality-control reports.
- C. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Submittals shall comply with the requirements of the Construction Contract Clauses, Section 013000 "Submittal Procedures" and the individual sections specifying the work.
- B. Operation and Maintenance Data: For electric heating cables to include in operation and maintenance manuals.

1.6 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace electric heating cable that fails in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Raychem HWAT product scheduled on Drawings or a comparable product by available manufacturers offering products that may be incorporated into the Work which include, but are not limited to, the following:
 - 1. [Chromalox](#).
 - 2. [Nelson Heat Trace](#); a division of EGS Electrical Group LLC.
 - 3. [Thermon Americas Inc.](#)
- B. Comply with IEEE 515.1.
- C. Heating Element: Pair of parallel No. 16 AWG, tinned or nickel-coated, stranded copper bus wires embedded in crosslinked conductive polymer core, which varies heat output in response to temperature along its length. Terminate with waterproof, factory-assembled, nonheating leads with connectors at one end, and seal the opposite end watertight. Cable shall be capable of crossing over itself once without overheating.
- D. Electrical Insulating Jacket: Flame-retardant polyolefin.
- E. Maximum Operating Temperature (Power On): 150 deg F.
- F. Maximum Exposure Temperature (Power Off): 185 deg F.
- G. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- H. Capacities and Characteristics: As scheduled on Drawings.

2.2 SELF-REGULATING, PARALLEL-RESISTANCE SNOW MELTING CABLES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Raychem EM2-XR product scheduled on Drawings or a comparable product by available manufacturers offering products that may be incorporated into the Work which include, but are not limited to, the following:
1. [Chromalox](#).
 2. [Nelson Heat Trace](#); a division of EGS Electrical Group LLC.
 3. [Thermon Americas Inc.](#)
- B. Comply with IEEE 515.1.
- C. Heating Element: Pair of parallel No. 14 AWG, nickel-coated, stranded copper bus wires embedded in crosslinked conductive polymer core, which varies heat output in response to temperature along its length. Terminate with waterproof, factory-assembled, nonheating leads with connectors at one end, and seal the opposite end watertight. Cable shall be capable of crossing over itself once without overheating.
- D. Electrical Insulating Jacket: Flame-retardant polyolefin.
- E. Maximum Operating Temperature (Power On): 275 deg F.
- F. Maximum Exposure Temperature (Power Off): 185 deg F.
- G. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- H. Capacities and Characteristics: As indicated on Drawings.

2.3 CONTROLS

- A. Electronic Controller for Domestic-Hot-Water-Temperature Maintenance: Microprocessor based controller with integral LED user interface for controlling self-regulating heating cables. Controller shall have as a minimum the following capabilities:
1. Flexible temperature control of hot water temperature maintenance with a variable temperature range of 105 deg F to 140 deg F.
 2. Integrated function that lowers the maintain temperature during low use hours to save energy.
 3. Heat-up cycle function that increases the water temperature of a hot water system not in use.
 4. Building Management System (BMS) interface that receives a 0-10 VDC signal to determine the desired maintain temperature for remote temperature maintenance.
 5. Alarm relays to signal power, temperature or communication problems to the BMS.
 6. Water heater sensor function that alarms and lowers the maintain temperature if the water heater temperature is too low.
 7. Master/slave function that allows one controller to control up to eight additional controllers.
 8. A minimum of seven predefined programs that can be customized by the user.

B. Electronic Controller for Snow Melting:

1. Microprocessor-based, automatic control with manual on, automatic, and standby/reset switch.
2. Precipitation and temperature sensors shall sense the conditions of slab and controller shall be programmed to energize the cable as follows:
 - a. Energize Cables: If ambient temperature is below set point and precipitation is detected.
 - b. De-Energize Cables: On detection of a dry surface or slab temperature set point is reached.
3. Minimum 30-A contactor to energize cable or close other contactors.
4. Precipitation sensor shall be slab mounted.
5. Provide relay with contacts to indicate operational status, on or off, for interface with central HVAC control-system workstation.

2.4 ACCESSORIES

- A. 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.
- B. Warning Tape: Continuously printed "Electrical Tracing"; vinyl, at least 3 mils thick, and with pressure-sensitive, permanent, waterproof, self-adhesive back.
 1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches: 3/4 inch minimum.
 2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches or Larger: 1-1/2 inches minimum.
- C. Snow Melt Caution Sign: 6 inch by 4 inch metal sign embedded in slab next to snow melt system.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine surfaces and substrates to receive electric heating cables for compliance with requirements for installation tolerances and other conditions affecting performance.
 1. Ensure surfaces and pipes in contact with electric heating cables are free of burrs and sharp protrusions.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Install the following types of electric heating cable for the applications described:
 - 1. Temperature Maintenance for Domestic Hot Water: Self-regulating, parallel-resistance heating cable.

3.3 INSTALLATION

- A. Install electric heating cable across expansion, construction, and control joints according to manufacturer's written instructions; use cable-protection conduit and slack cable to allow movement without damage to cable.
- B. Electric Heating-Cable Installation for Temperature Maintenance for Domestic Hot Water:
 - 1. Install electric heating cables after piping has been tested and before insulation is installed.
 - 2. Install insulation over piping with electric heating cables according to Section 220719 "Plumbing Piping Insulation."
 - 3. Install warning tape on piping insulation where piping is equipped with electric heating cables.
- C. Set field-adjustable switches and circuit-breaker trip ranges.

3.4 SNOW MELT INSTALLATION

- A. The heating cable shall be installed according to the manufacturer's recommendations.
- B. The heating cable shall be installed only in concrete pavement designed for long term structural integrity. The pavement shall be reinforced with rebar and the reinforcing supported such that the location of the reinforcing and the attached heating cable is not disturbed during the concrete placement. The rebar shall be placed at the heating-cable depth whenever possible.
- C. The heating cable shall be protected from where it leaves the pavement to the junction box by installing the cable in 1-inch rigid metal conduit. Use one conduit for each heating cable.
- D. The power connection and end seal junction box shall be mounted above grade. The junction box shall be installed so that water cannot enter it.
- E. Heating-cable repairs and splices shall be made using a splice kit provided by the manufacturer and specifically approved for the purpose. They shall pass the Megger test after installation.

3.5 CONNECTIONS

- A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.6 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Perform tests after cable installation but before application of coverings such as insulation, wall or ceiling construction, or concrete.
 - 2. Test cables for electrical continuity and insulation integrity before energizing.
 - 3. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.
 - 4. The snow melt heating cable shall be tested for insulation resistance with a 2500-Vdc Megger after installation, during the concrete pour, and annually thereafter according to the manufacturer's recommendations.
- C. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounted cables.
- D. Cables will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.

3.7 PROTECTION

- A. Protect installed heating cables, including nonheating leads, from damage during construction.
- B. Remove and replace damaged heat-tracing cables.

END OF SECTION

SECTION 220533 - HEAT TRACING FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes plumbing piping heat tracing for freeze prevention, domestic hot-water-temperature maintenance, and snow and ice melting on roofs and in gutters and downspouts with the following electric heating cables:
 - 1. Self-regulating, parallel resistance.

1.3 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Product Data: For each type of product. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.
 - 1. Include rated capacities, operating characteristics, and furnished specialties and accessories.
 - 2. Schedule heating capacity, length of cable, spacing, and electrical power requirement for each electric heating cable required.
- C. Shop Drawings: For electric heating cable.
 - 1. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Field quality-control reports.
- C. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 “Submittal Procedures” and the individual sections specifying the work.
- B. Operation and Maintenance Data: For electric heating cables to include in operation and maintenance manuals.

1.6 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace electric heating cable that fails in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Tyco HWAT System scheduled on Drawings or a comparable product by available manufacturers offering products that may be incorporated into the Work which includes, but is not limited to, the following:
 - 1. Chromalox.
 - 2. Thermor Americas Inc.
- B. Comply with IEEE 515.1.
- C. Heating Element: Pair of parallel No. 16 or No. 18 AWG, tinned, stranded copper bus wires embedded in crosslinked conductive polymer core, which varies heat output in response to temperature along its length. Terminate with waterproof, factory-assembled, nonheating leads with connectors at one end, and seal the opposite end watertight. Cable shall be capable of crossing over itself once without overheating.
- D. Electrical Insulating Jacket: Flame-retardant polyolefin.
- E. Cable Cover: Tinned-copper or stainless-steel braid and polyolefin outer jacket with ultraviolet inhibitor.
- F. Maximum Operating Temperature (Power On): 150 deg F.
- G. Maximum Exposure Temperature (Power Off): 185 deg F.
- H. 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.
- I. Capacities and Characteristics: As scheduled on Drawings.

2.2 CONTROLS

- A. Electronic Controller for Domestic-Hot-Water-Temperature Maintenance: Microprocessor based controller with integral LED user interface for controlling self-regulating heating cables. Controller shall have as a minimum the following capabilities:
1. Flexible temperature control of hot water temperature maintenance with a variable temperature range of 105 deg F to 140 deg F.
 2. Integrated function that lowers the maintain temperature during low use hours to save energy.
 3. Heat-up cycle function that increases the water temperature of a hot water system not in use.
 4. Building Management System (BMS) interface that receives a 0-10 VDC signal to determine the desired maintain temperature for remote temperature maintenance.
 5. Alarm relays to signal power, temperature or communication problems to the BMS.
 6. Water heater sensor function that alarms and lowers the maintain temperature if the water heater temperature is too low.
 7. Master/slave function that allows one controller to control up to eight additional controllers.
 8. A minimum of seven predefined programs that can be customized by the user.

2.3 ACCESSORIES

- A. 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.
- B. Warning Labels: Refer to Section 220553 "Identification for Plumbing Piping and Equipment."
- C. Warning Tape: Continuously printed "Electrical Tracing"; vinyl, at least 3 mils thick, and with pressure-sensitive, permanent, waterproof, self-adhesive back.
1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches: 3/4 inch minimum.
 2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches or Larger: 1-1/2 inches minimum.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine surfaces and substrates to receive electric heating cables for compliance with requirements for installation tolerances and other conditions affecting performance.
1. Ensure surfaces and pipes in contact with electric heating cables are free of burrs and sharp protrusions.

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

3.2 APPLICATIONS

- A. Install the following types of electric heating cable for the applications described:
 - 1. Temperature Maintenance for Domestic Hot Water: Self-regulating, parallel-resistance heating cable.

3.3 INSTALLATION

- A. Install electric heating cable across expansion, construction, and control joints according to manufacturer's written instructions; use cable-protection conduit and slack cable to allow movement without damage to cable.
- B. Electric Heating-Cable Installation for Temperature Maintenance for Domestic Hot Water:
 - 1. Install electric heating cables after piping has been tested and before insulation is installed.
 - 2. Install insulation over piping with electric heating cables according to Section 220719 "Plumbing Piping Insulation."
 - 3. Install warning tape on piping insulation where piping is equipped with electric heating cables.
- C. Set field-adjustable switches and circuit-breaker trip ranges.

3.4 CONNECTIONS

- A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Perform tests after cable installation but before application of coverings such as insulation, wall or ceiling construction, or concrete.
 - 2. Test cables for electrical continuity and insulation integrity before energizing.
 - 3. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.

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- C. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounted cables.
- D. Cables will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.

3.6 PROTECTION

- A. Protect installed heating cables, including nonheating leads, from damage during construction.
- B. Remove and replace damaged heat-tracing cables.

3.7 DEMONSTRATION

- A. Train Owner's maintenance personnel how to adjust, maintain, test, and repair temperature maintenance system.

END OF SECTION

SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Equipment labels.
- 2. Pipe labels.
- 3. Valve tags.
- 4. Warning tags.

1.3 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Product Data: For each type of product indicated. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.
- C. Samples: For color, letter style, and graphic representation required for each identification material and device.
- D. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- E. Valve numbering scheme.
- F. Valve Schedules: For each piping system to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

- A. Plastic Labels for Equipment:

- 1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.

2. Letter Color: White.
3. Background Color: Red.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment number.

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

2.2 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 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; also include pipe size and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping-system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: Size letters according to ASME A13.1 for piping.

2.3 VALVE TAGS

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

1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass wire-link chain.

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

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

2.4 WARNING TAGS

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

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 GENERAL INSTALLATION REQUIREMENTS

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

3.3 EQUIPMENT LABEL INSTALLATION

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

3.4 PIPE LABEL INSTALLATION

- A. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve and control device.
 - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
 - 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
- B. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.
- C. Pipe Label Color Schedule:
 - 1. Domestic Water Piping
 - a. Background: Safety green.
 - b. Letter Colors: White.
 - 2. Sanitary Waste and Vent, and Storm Drainage Piping:
 - a. Background Color: Safety white.
 - b. Letter Color: Black.

3.5 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, faucets, convenience and lawn-watering hose connections, and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
 - 1. Valve-Tags:
 - a. Valve-Tag Size and Shape: 2 inches, round.
 - b. Valve-Tag Color: Natural.
 - c. Letter Colors: Black.

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3.6 WARNING-TAG INSTALLATION

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

END OF SECTION

SECTION 220719 - PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes insulating the following plumbing piping services:
 - 1. Domestic cold-water piping.
 - 2. Domestic hot-water piping.
 - 3. Roof drains and rainwater leaders.
- B. Related Sections:
 - 1. Section 224216.13 "Commercial Lavatories" and Section 224216.16 "Commercial Sinks" for protective shielding coverage for supplies and drains for handicapped-accessible fixtures.
- C. Sustainable Design Requirements: Work included in this specification shall conform to the US Green Building Council LEED requirements listed in Section 018113.23 "Sustainable Design Requirements - LEED 2009 for Schools."

1.3 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.
- C. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied, if any).
- D. Sustainable Design Submittals:
 - 1. Product Data: For adhesives, mastics, and sealants, indicating VOC content.
 - 2. Laboratory Test Reports: For adhesives, mastics, and sealants, indicating compliance with requirements for low-emitting materials.
- E. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail attachment and covering of heat tracing inside insulation.
3. Detail insulation application at pipe expansion joints for each type of insulation.
4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
5. Detail removable insulation at piping specialties, equipment connections, and access panels.
6. Detail application of field-applied jackets.
7. Detail application at linkages of control devices.

1.4 INFORMATIONAL SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 “Submittal Procedures” and the individual sections specifying the work.
- B. Qualification Data: For qualified Installer.
- C. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
- D. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing agency acceptable to 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.

1.6 DELIVERY, STORAGE, AND HANDLING

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

1.7 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing for temperature maintenance system.

1.8 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in "Piping Insulation Schedule, General" and "Indoor Piping Insulation Schedule" articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.
- G. Mineral-Fiber, Preformed Pipe Insulation:
 - 1. Type I, 850 Deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 INSULATING CEMENTS

- A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.
- B. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.

2.3 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.
- B. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.
 - 1. Adhesives and sealants 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."
- C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 - 1. Adhesive: As recommended by mineral fiber manufacturer and with a VOC content of 80 g/L or less.
 - 2. Adhesives and sealants 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."
- D. PVC Jacket Adhesive: Compatible with PVC jacket.
 - 1. Adhesive: As recommended by Adhesive - PVC Jacket manufacturer and with a VOC content of 50 g/L or less.
 - 2. Adhesives and sealants 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."

2.4 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
 - 1. 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 use on below-ambient services.

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1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F.
3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
4. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.

1. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F.
3. Solids Content: 60 percent by volume and 66 percent by weight.
4. Color: White.

2.5 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. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
3. Service Temperature Range: 0 to plus 180 deg F.
4. Color: White.

2.6 SEALANTS

A. ASJ Flashing Sealants and PVC Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: White.
5. 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."

2.7 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.

2.8 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
 - 1. Adhesive: As recommended by jacket material manufacturer.
 - 2. Color: White.
 - 3. 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.

2.9 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
 - 1. Width: 3 inches.
 - 2. Thickness: 11.5 mils.
 - 3. Adhesion: 90 ounces force/inch in width.
 - 4. Elongation: 2 percent.
 - 5. Tensile Strength: 40 lbf/inch in width.
 - 6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
 - 1. Width: 2 inches.
 - 2. Thickness: 6 mils.
 - 3. Adhesion: 64 ounces force/inch in width.
 - 4. Elongation: 500 percent.
 - 5. Tensile Strength: 18 lbf/inch in width.

2.10 SECUREMENTS

- A. Bands:
 - 1. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch wide with wing seal or closed seal.
- B. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.
- C. Wire: 0.062-inch soft-annealed, stainless steel.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.

- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
 - a. For below-ambient services, apply vapor-barrier mastic over staples.
 - 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- P. For above-ambient services, do not install insulation to the following:
 - 1. Vibration-control devices.
 - 2. Testing agency labels and stamps.
 - 3. Nameplates and data plates.
 - 4. Cleanouts.

3.4 PENETRATIONS

- A. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- B. Insulation Installation at Aboveground Exterior Wall Penetrations:
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant.
 - 3. Seal jacket to wall flashing with flashing sealant.
- C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
 - 1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.
- E. Insulation Installation at Floor Penetrations:
 - 1. Pipe: Install insulation continuously through floor penetrations.
 - 2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
 - 1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
 - 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 - 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 - 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve

- stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
 6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
 3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
 4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- B. Insulation Installation on Pipe Flanges:
 - 1. Install pipe insulation to outer diameter of pipe flange.
 - 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 - 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
 - 4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Insulation Installation on Pipe Fittings and Elbows:
 - 1. Install mitered sections of pipe insulation.
 - 2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- D. Insulation Installation on Valves and Pipe Specialties:
 - 1. Install preformed valve covers manufactured of same material as pipe insulation when available.
 - 2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 - 3. Install insulation to flanges as specified for flange insulation application.
 - 4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.7 INSTALLATION OF MINERAL-FIBER INSULATION

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

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

C. Insulation Installation on Pipe Fittings and Elbows:

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

D. Insulation Installation on Valves and Pipe Specialties:

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

3.8 FIELD-APPLIED JACKET INSTALLATION

- A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints. 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.

3.9 FINISHES

- A. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

3.10 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. 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, two locations of threaded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

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

3.11 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
 - 1. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.12 INDOOR PIPING INSULATION SCHEDULE

- A. Domestic Cold Water:
 - 1. NPS 1 and Smaller: Insulation shall be the following:
 - a. Flexible Elastomeric: 1/2 inch thick.
 - 2. NPS 1-1/4 and Larger: Insulation shall be the following:
 - a. Flexible Elastomeric: 1 inch thick.
 - 3. Vapor Barrier: Required.
- B. Domestic Hot Water:
 - 1. NPS 1-1/4 and Smaller Without Temperature Maintenance System: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
 - 2. NPS 1-1/2 and Larger Without Temperature Maintenance System: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1-1/2 inches thick.
 - 3. For hot water piping with temperature maintenance (heat trace) system provide mineral-fiber, preformed pipe insulation, Type I insulation according to the following schedule with enlarged insulation pipe sizes to accommodate the heat trace cables, or as recommended by temperature maintenance system manufacturer, whichever is more conservative.

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<u>Nominal Installed Pipe Size</u>	<u>Insulation Thickness</u>	<u>Nominal Pipe Insulation Size</u>
1/2"	1 inch	3/4"
3/4"	1 inch	1"
1"	1 inch	1-1/4"
1-1/4"	1-1/2 inch	1-1/2"
1-1/2"	1-1/2 inch	1-1/2"
2"	1-1/2 inch	2"
2-1/2"	2 inch	2-1/2"
3"	2 inch	3"

4. Vapor Barrier: Not Required.

C. Stormwater and Overflow:

1. All Pipe Sizes: Insulation shall be the following:

- a. Flexible Elastomeric: 1 inch thick.
- b. Vapor Barrier: Required.

D. Roof Drain and Overflow Drain Bodies:

1. All Pipe Sizes: Insulation shall be the following:

- a. Flexible Elastomeric: 1 inch thick.
- b. Vapor Barrier: Required.

E. Floor Drains, Traps, and Sanitary Drain Piping within 10 Feet of Drain Receiving Condensate and Equipment Drain Water below 60 Deg F:

1. All Pipe Sizes: Insulation shall be the following:

- a. Flexible Elastomeric: 3/4 inch thick.
- b. Vapor Barrier: Required.

3.13 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed:

1. None.

D. Exposed, vertical roof leader or domestic water piping risers to 8 feet above finished floor:

1. PVC: 20 mils thick.

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- E. Exposed domestic water piping in kitchen and scullery areas;
 - 1. PVC: 20 mils thick.

END OF SECTION

SECTION 221116 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

- 1. Under-building slab and aboveground domestic water pipes, tubes, and fittings inside buildings.

B. Related Requirements:

- 1. Section 221113 "Facility Water Distribution Piping" for water-service piping outside the building from source to the point where water-service piping enters the building.

- C. Sustainable Design Requirements: Work included in this specification shall conform to the US Green Building Council LEED requirements listed in Section 018113.23 "Sustainable Design Requirements - LEED 2009 for Schools."

1.3 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of the Section 013300 "Submittal Procedures" and the individual sections specifying the work.

- B. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.

- C. Product Data: Domestic water pipes, tubes, and fittings.

- D. Product Data: For transition fittings and dielectric fittings.

E. Sustainable Design Submittals:

- 1. **Product Data:** For adhesives, indicating VOC content.
- 2. **Laboratory Test Reports:** For adhesives, indicating compliance with requirements for low-emitting materials.

1.4 INFORMATIONAL SUBMITTALS

- A. Submittals shall comply with the requirements of the Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. System purging and disinfecting activities report.
- C. Field quality-control reports.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. 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.
- B. Potable-water piping and components shall comply with NSF 14 and NSF 61 Annex G. Plastic piping components shall be marked with "NSF-pw."
- C. Comply with NSF Standard 372 for low lead.

2.2 DUCTILE-IRON PIPE AND FITTINGS

- A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated, with AWWA C104 cement lining and seal coating.
 - 1. Interior seal coating: bituminous paint oil cut, emulsion not acceptable, with a minimum dry film thickness of 2 mils.
 - 2. Exterior seal coating: bituminous seal coating, with a minimum dry film thickness of 2 mils.
 - 3. Mechanical-Joint, Ductile-Iron Fittings: ASTM A536, grade 70-50-05, in accordance with AWWA C153, compact pattern, Class 350
 - a. Lining: AWWA C104 cement lining or AWWA C550 and C116 fusion bonded epoxy coating with 5 mils nominal thickness.
 - b. Interior seal coating: AWWA C104 with a minimum dry film thickness of 4 mils.
 - c. Exterior seal coating: bituminous seal coating with a minimum dry film thickness of 4 mils or fusion bonded epoxy coated with a minimum nominal thickness of 5 mils per AWWA C550 and AWWA C116.
 - d. Fittings must provide adequate space for the mechanical joint and accessories to be installed without special tools (i.e. Lowell wrench can be used).
 - 4. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and High Strength/Low Alloy (Cor-Ten) steel bolts and nuts.

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- B. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated, with AWWA C104 cement lining and seal coating.
 - 1. Interior seal coating: bituminous paint oil cut, emulsion not acceptable, with a minimum dry film thickness of 2 mils.
 - 2. Exterior seal coating: bituminous seal coating, with a minimum dry film thickness of 2 mils.
 - 3. 4 Inch through 12 Inch: Thickness Class 52.
 - 4. Gaskets: AWWA C111, rubber.

- C. Pipe and joint manufacturer shall be approved by PWD. Approved manufacturers include:
 - 1. American Cast Iron Pipe.
 - 2. Griffin Pipe.
 - 3. U.S. Pipe.
 - 4. Clow Pipe.
 - 5. McWain Pipe.
 - 6. Atlantic States Pipe.

2.3 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.
- B. Soft Copper Tube: ASTM B 88, Type M water tube, annealed temper.
- C. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
- D. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
- E. Copper Unions:
 - 1. MSS SP-123.
 - 2. Cast-copper-alloy, hexagonal-stock body.
 - 3. Ball-and-socket, metal-to-metal seating surfaces.
 - 4. Solder-joint or threaded ends.

2.4 PEX TUBE AND FITTINGS

- A. PEX Distribution System: ASTM F 877, SDR 9 tubing.
- B. Fittings for PEX Tube: ASTM F 1807, metal insert type with copper or stainless-steel crimp rings and matching PEX tube dimensions.

2.5 PE PIPE AND FITTINGS

- A. PE, ASTM Pipe: AWWA C 901 and ASTM D 3035; with dimension ratio and PE compound number required to give pressure rating not less than 200 psig.
 - 1. Molded PE Fittings: ASTM D 3350, PE resin, socket- or butt-fusion type, made to match PE pipe dimensions and class.
- B. PE CTS Tubing: AWWA C 901 and ASTM D 2737 with working pressure rating of 200 psi.
 - 1. Compression Fittings for CTS Tubing: All brass with insert stiffeners.

2.6 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- B. Dielectric Unions:
 - 1. Standard: ASSE 1079.
 - 2. Pressure Rating: 125 psig minimum at 180 deg F.
 - 3. End Connections: Solder-joint copper alloy and threaded ferrous.
- C. Dielectric Flanges:
 - 1. Standard: ASSE 1079.
 - 2. Factory-fabricated, bolted, companion-flange assembly.
 - 3. Pressure Rating: 125 psig minimum at 180 deg F.
 - 4. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
- D. Dielectric-Flange Insulating Kits:
 - 1. Nonconducting materials for field assembly of companion flanges.
 - 2. Pressure Rating: 150 psig.
 - 3. Gasket: Neoprene or phenolic.
 - 4. Bolt Sleeves: Phenolic or polyethylene.
 - 5. Washers: Phenolic with steel backing washers.
- E. Dielectric Nipples:
 - 1. Standard: IAPMO PS 66.
 - 2. Electroplated steel nipple complying with ASTM F 1545.
 - 3. Pressure Rating and Temperature: 300 psig at 225 deg F.
 - 4. End Connections: Male threaded or grooved.
 - 5. Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING INSTALLATION

- A. 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.
- B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."
- C. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve inside the building at domestic water-service entrance. Comply with requirements for pressure gages in Section 220519 "Meters and Gages for Plumbing Piping" and with requirements for drain valves and strainers in Section 221119 "Domestic Water Piping Specialties."
- D. Install shutoff valve immediately upstream of each dielectric fitting.
- E. Install domestic water piping level and plumb.
- F. Rough-in domestic water piping for water-meter installation according to utility company's requirements.
- G. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- H. 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.
- I. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- J. Install piping to permit valve servicing.
- K. 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.
- L. Install piping free of sags and bends.
- M. Install fittings for changes in direction and branch connections.
- N. Install PEX tubing with loop at each change of direction of more than 90 degrees.

- O. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
- P. Install thermometers on inlet and outlet piping from each water heater. Comply with requirements for thermometers in Section 220519 "Meters and Gages for Plumbing Piping."
- Q. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- R. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- S. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.3 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. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."
- D. 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.
- E. Joints for PEX Tubing: Join according to ASTM F 1807 for metal insert and copper crimp ring fittings and ASTM F 1960 for cold expansion fittings and reinforcing rings.
- F. PE Piping Compression-Fitting Joints: Use brass compression fittings according to manufacturer's written instructions.
- G. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.4 TRANSITION FITTING INSTALLATION

- A. Install transition couplings at joints of dissimilar piping.

3.5 DIELECTRIC FITTING INSTALLATION

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

3.6 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for pipe hanger, support products, and installation in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
 - 1. Vertical Piping: MSS Type 8 or 42, clamps.
 - 2. Individual, Straight, Horizontal Piping Runs:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
 - 3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 - 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- B. Support vertical piping and tubing at base and at each floor.
- C. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.
- D. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
 - 2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
 - 3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
 - 4. NPS 2-1/2: 108 inches with 1/2-inch rod.
 - 5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
- E. Install supports for vertical copper tubing every 10 feet.
- F. Support piping and tubing not listed in this article according to MSS SP-58 and manufacturer's written instructions.

3.7 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.
- C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.
- D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
 - 1. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.

2. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
3. 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 and larger.

3.8 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification materials and installation in Section 220553 "Identification for Plumbing Piping and Equipment."

3.9 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:

1. Piping Inspections:

- a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
- b. 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:
 - 1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
 - 2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.
- c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
- d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

2. Piping Tests:

- a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
- b. 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.
- c. 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.
- d. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.

- e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
 - f. Prepare reports for tests and for corrective action required.
- B. Domestic water piping will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.10 ADJUSTING

- A. Perform the following adjustments before operation:
- 1. Close drain valves, hydrants, and hose bibbs.
 - 2. Open shutoff valves to fully open position.
 - 3. Open throttling valves to proper setting.
 - 4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
 - a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
 - b. Adjust calibrated balancing valves to flows indicated.
 - 5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
 - 6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
 - 7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
 - 8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.11 CLEANING

- A. Clean and disinfect potable domestic water piping as follows:
- 1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
 - 2. 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:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Fill and isolate system according to either of the following:
 - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
 - 2) Fill system or part thereof with water/chlorine solution with at least 200 ppm 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.
 - d. Repeat procedures if biological examination shows contamination.
 - e. Submit water samples in sterile bottles to authorities having jurisdiction.
- B. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.
- C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.12 PIPING SCHEDULE

- A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
- B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.
- C. Under-building-slab, trap primer piping, shall be the following:
- 1. PEX tube with crimped joints.
- D. Aboveground trap primer piping shall be the following:
- 1. Soft copper tube, ASTM B 88, Type M; cast- or wrought-copper, solder-joint fittings; and soldered joints.
- E. Aboveground domestic water piping, shall be the following:
- 1. Hard copper tube, ASTM B 88, Type L; cast- or wrought-copper, solder-joint fittings; and soldered joints.
- F. Under-building slab, domestic water, non-potable application piping, NPS 2 and smaller, shall be the following:
- 1. PE ASTM pipe; insert fittings for PE pipe; and clamped joints.
- G. Under-building slab, domestic water, building-service piping shall be the following:
- 1. Mechanical-joint, ductile iron pipe; standard- or compact-pattern, mechanical-joint fittings; and mechanical joints.

3.13 VALVE SCHEDULE

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
- 1. Shutoff Duty: Use ball valves.
 - 2. Throttling Duty: Use ball valves.
 - 3. Drain Duty: Hose-end drain valves.

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- B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

END OF SECTION

SECTION 221119 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Vacuum breakers.
2. Backflow preventers.
3. Temperature-actuated, water mixing valves.
4. Strainers.
5. Outlet boxes.
6. Hose bibbs.
7. Wall hydrants.
8. Drain valves.
9. Water-hammer arresters.
10. Air vents.
11. Trap-seal primer valves.
12. Trap-seal primer systems.
13. Flexible connectors and expansion loops.
14. Water meters.

B. Related Requirements:

1. Section 220519 "Meters and Gages for Plumbing Piping" for thermometers, and pressure gages in domestic water piping.
2. Section 224500 "Emergency Plumbing Fixtures" for water tempering equipment for those fixtures.
3. Section 224716 "Pressure Water Coolers" for water filters for water coolers.

- C. Sustainable Design Requirements: Work included in this specification shall conform to the US Green Building Council LEED requirements listed in Section 018113.23 "Sustainable Design Requirements - LEED 2009 for Schools."

1.3 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of the Section 013300 "Submittal Procedures" and the individual sections specifying the work.

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- B. Product Data: For each type of product. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.
- C. Shop Drawings: For domestic water piping specialties.
 - 1. Include diagrams for power, signal, and control wiring.
- D. Sustainable Design Submittals:
 - 1. Product Data: For water consumption data for LEED compliance.

1.4 INFORMATIONAL SUBMITTALS

- A. Submittals shall comply with the requirements of the Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Submittals shall comply with the requirements of the Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

- A. Potable-water piping and components shall comply with NSF 61 Annex G, NSF 14, and NSF 372.

2.2 PERFORMANCE REQUIREMENTS

- A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig unless otherwise indicated.

2.3 VACUUM BREAKERS

- A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:
 - 1. Standard: ASSE 1001.
 - 2. Size: NPS 1/4 to NPS 3, as required to match connected piping.
 - 3. Body: Bronze.

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4. Inlet and Outlet Connections: Threaded.
5. Finish: Rough bronze or chrome plated.

B. Hose-Connection Vacuum Breakers:

1. Standard: ASSE 1011.
2. Body: Bronze, nonremovable, with manual drain.
3. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
4. Finish: Chrome or nickel plated.

2.4 BACKFLOW PREVENTERS

A. Reduced-Pressure-Principle Backflow Preventers (BFP):

1. Basis-of-Design Product: Subject to compliance with requirements, provide Wilkins product scheduled on Drawings or a comparable product by one of the following:
 - a. Ames Co.
 - b. Conbraco Industries, Inc.
 - c. Watts; a Watts Water Technologies company.
 - d. Zurn Industries, LLC.
2. Standard: ASSE 1013.
3. Operation: Continuous-pressure applications.
4. Pressure Loss at Design Flow Rate: As indicated on drawings
5. Body: Bronze for NPS 2 and smaller; cast iron or steel with interior lining that complies with AWWA C550 or that is FDA approved for NPS 2-1/2 and larger.
6. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
7. Configuration: Designed for horizontal, straight-through flow.
8. Accessories:
 - a. Valves NPS 2 and Smaller: Ball type with threaded ends on inlet and outlet.
 - b. Valves NPS 2-1/2 and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.
 - c. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.
9. Capacity and Characteristics: As scheduled on Drawings.

2.5 TEMPERATURE-ACTUATED, WATER MIXING VALVES

A. Water-Temperature Limiting Devices:

1. Standard: ASSE 1017.
2. Pressure Rating: 125 psig.
3. Type: Thermostatically controlled, water mixing valve.
4. Material: Bronze body with corrosion-resistant interior components.
5. Connections: Threaded inlets and outlet.

6. Accessories: Check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.

B. Primary, Thermostatic, Water Mixing Valves (TMV):

1. Basis-of-Design Product: Subject to compliance with requirements, provide Leonard Valve Company product scheduled on Drawings or a comparable product by one of the following:
 - a. Armstrong International Inc.
 - b. Lawler Manufacturing Co., Inc.
 - c. Powers.
 - d. Symmons Industries Inc.
 - e. Zurn Industries, LLC.
2. Standard: ASSE 1017.
3. Pressure Rating: 125 psig minimum unless otherwise indicated.
4. Type: Exposed-mounted or cabinet-type as scheduled, thermostatically controlled, water mixing valve.
5. Material: Bronze body with corrosion-resistant interior components.
6. Connections: Threaded union inlets and outlet.
7. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
8. Valve Finish: Rough bronze.
9. Cabinet: Factory fabricated, stainless steel mounting and with hinged, stainless-steel door where scheduled.
10. Capacity and Characteristics: As scheduled on Drawings.

2.6 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:

1. Pressure Rating: 125 psig minimum unless otherwise indicated.
2. Body: Bronze for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved, epoxy coated for NPS 2-1/2 and larger.
3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
4. Screen: Stainless steel with round perforations unless otherwise indicated.
5. Perforation Size:
 - a. Strainers NPS 2 and Smaller: 0.033 inch.
 - b. Strainers NPS 2-1/2 to NPS 4: 0.062 inch.
6. Drain: Factory-installed, hose-end drain valve.

2.7 OUTLET BOXES

A. Clothes Washer Outlet Boxes (WOB):

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1. Mounting: Recessed.
2. Material and Finish: Enameled-steel or epoxy-painted-steel box and faceplate.
3. Faucet: Combination valved fitting or separate hot- and cold-water valved fittings complying with ASME A112.18.1. Include garden-hose thread complying with ASME B1.20.7 on outlets.
4. Supply Shutoff Fittings: NPS 1/2 ball valves and NPS 1/2 copper, water tubing with factory water hammer arrestors.
5. Drain: NPS 2 standpipe and P-trap for direct waste connection to drainage piping.

B. Icemaker Outlet Boxes (IOB):

1. Mounting: Recessed.
2. Material and Finish: Enameled-steel or epoxy-painted-steel box and faceplate.
3. Faucet: Valved fitting complying with ASME A112.18.1. Include NPS 1/2 or smaller copper tube outlet.
4. Supply Shutoff Fitting: NPS 1/2 ball valve and NPS 1/2 copper, water tubing.

2.8 HOSE BIBBS

A. Hose Bibbs (HB):

1. Standard: ASME A112.18.1 for sediment faucets.
2. Body Material: Bronze.
3. Seat: Bronze, replaceable.
4. Supply Connections: NPS 1/2 or NPS 3/4 threaded or solder-joint inlet.
5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
6. Pressure Rating: 125 psig.
7. Vacuum Breaker: Integral nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
8. Finish for Equipment Rooms and Service Areas: Rough bronze, or chrome or nickel plated.
9. Finish for Finished Rooms: Chrome or nickel plated.
10. Operation for Equipment Rooms and Service Areas: Wheel handle or operating key.
11. Operation for Finished Rooms: Wall handle or operating key.
12. Include operating key with each operating-key hose bibb.
13. Include integral wall flange with each chrome- or nickel-plated hose bibb.

2.9 WALL HYDRANTS

A. Nonfreeze Wall Hydrants, Concealed (NFWH):

1. Standard: ASME A112.21.3M for concealed-outlet, self-draining wall hydrants.
2. Pressure Rating: 125 psig.
3. Operation: Loose key.
4. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
5. Inlet: NPS 3/4.

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6. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
7. Box: Deep, flush mounted with cover.
8. Box and Cover Finish: Polished nickel bronze.
9. Nozzle and Wall-Plate Finish: Polished nickel bronze.
10. Operating Keys(s): Two with each wall hydrant.

B. Moderate-Climate Wall Hydrants, Narrow Wall Installation (WH):

1. Standard: ASME A112.21.3M for exposed-outlet, self-draining wall hydrants for narrow wall installation.
2. Pressure Rating: 125 psig.
3. Operation: Loose key.
4. Inlet: NPS 3/4.
5. Outlet: Exposed, with integral vacuum breaker or nonremovable hose-connection vacuum breaker comply with ASSE 1011; and garden-hose thread complying with ASME B1.20.7.
6. Box: Deep, flush mounted with cover.
7. Box and Cover Finish: Polished nickel bronze.
8. Nozzle and Wall-Plate Finish: Polished nickel.
9. Operating Keys(s): One with each wall hydrant.

2.10 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Pressure Rating: 400-psig minimum CWP.
3. Size: NPS 3/4.
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

B. Stop-and-Waste Drain Valves:

1. Standard: MSS SP-110 for ball valves or MSS SP-80 for gate valves.
2. Pressure Rating: 200-psig minimum CWP or Class 125.
3. Size: NPS 3/4.
4. Body: Copper alloy or ASTM B 62 bronze.
5. Drain: NPS 1/8 side outlet with cap.

2.11 WATER-HAMMER ARRESTERS

A. Water-Hammer Arresters (WHA):

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1. Standard: ASSE 1010 or PDI-WH 201.
2. Type: Copper tube with piston.
3. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

2.12 AIR VENTS

A. Welded-Construction Automatic Air Vents:

1. Body: Stainless steel.
2. Pressure Rating: 150-psig minimum pressure rating.
3. Float: Replaceable, corrosion-resistant metal.
4. Mechanism and Seat: Stainless steel.
5. Size: NPS 3/8 minimum inlet.
6. Inlet and Vent Outlet End Connections: Threaded.

2.13 TRAP-SEAL PRIMER DEVICE

A. Supply-Type, Trap-Seal Primer Device (TPV):

1. Basis-of-Design Product: Subject to compliance with requirements, provide Precision Plumbing Products Inc. product scheduled on Drawings or comparable product by one of the following:
 - a. MIFAB, Inc.
 - b. Sioux Chief Manufacturing Company, Inc.
 - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - d. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
2. Standard: ASSE 1018.
3. Pressure Rating: 125 psig minimum.
4. Body: Bronze.
5. Inlet and Outlet Connections: NPS 1/2 threaded, union, or solder joint.
6. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.

2.14 TRAP-SEAL PRIMER SYSTEMS

A. Trap-Seal Primer Systems (TPA):

1. Basis-of-Design Product: Subject to compliance with requirements, provide Precision Plumbing Products Inc. product scheduled on drawings or a comparable product.
2. Standard: ASSE 1044.
3. Piping: NPS 3/4, ASTM B 88, Type L; copper, water tubing.
4. Cabinet: Recessed- or surface-mounted, as scheduled; steel box with manufacturer's stainless-steel cover.
5. Electric Controls: 24-hour timer, solenoid valve, and manual switch for 120-V ac power.

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- 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.
6. Vacuum Breaker: ASSE 1001.
7. Number Outlets: As scheduled on drawings.
8. Size Outlets: NPS 1/2.

2.15 FLEXIBLE CONNECTORS AND EXPANSION LOOPS

- A. Flexible connectors shall have materials suitable for system fluid. Include 175-psig minimum working-pressure rating and ends according to the following:
 1. NPS 2 and Smaller: Threaded.
 2. NPS 2-1/2 and Larger: Flanged.
- B. Flexible Expansion Loop: Prefabricated flexible loop with three sections of metal hose and braid connected with 90 degree elbows or two sections of metal hose and braid connected with 180 degree elbow. Center elbow shall be provided with drain/air plug and center support nut. Expansion loop shall accommodate a minimum of 3 inches of expansion.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Flex-Hose Co., Inc.
 - b. Flexicraft Industries.
 - c. Metraflex, Inc.

2.16 WATER METERS

- A. Water meter shall be furnished and installed by local water utility company: Portland Water District (Tel: 207-774-5961).
- B. Contractor shall provide pipe flanges and spool section at water service entrance as directed by utility company, and shall contact utility company to schedule meter installation.
- C. Water meter shall be provided with pulse output for connection to building DDC system under Section 23092 "Instrumentation and Control for HVAC."
- D. Remote Registration System: Direct-reading type complying with AWWA C706; modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly as required by utility company.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. 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.
 - 1. Locate backflow preventers in same room as connected equipment or system.
 - 2. 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.
 - 3. Do not install bypass piping around backflow preventers.
- B. Install temperature-actuated, water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.
 - 1. Install cabinet-type units recessed in or surface mounted on wall as specified.
- C. Install Y-pattern strainers for water on supply side of each water pressure-reducing valve.
- D. Install outlet boxes recessed in wall. Install 2-by-4-inch fire-retardant-treated-wood blocking, wall reinforcement between studs. Comply with requirements for fire-retardant-treated-wood blocking in Section 061000 "Rough Carpentry."
- E. Install water-hammer arresters in water piping according to PDI-WH 201.
- F. Install air vents at high points of water piping.
- G. Install supply-type, trap seal-primer valves with outlet piping pitched down toward drain trap at a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.
- H. 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.
- I. Install water meters in accordance with requirements of municipal water department and manufacturer's written instructions. Install meter on incoming water main.

3.2 CONNECTIONS

- A. Comply with requirements for ground equipment in Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Fire-retardant-treated-wood blocking is specified in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for electrical connections.
- C. Install piping and specialties adjacent to equipment to allow service and maintenance.

3.3 LABELING AND IDENTIFYING

- A. Equipment Labels and Signs: Install engraved plastic-laminate equipment label or sign on or near each of the following:
 - 1. Reduced-pressure-principal backflow prevents.
 - 2. Manifold, thermostatic, water mixing-valve assemblies.
 - 3. Trap-seal primer systems.
- B. Distinguish among multiple units in addition to identifying unit. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Test each pressure vacuum breaker and reduced-pressure-principle backflow preventer, assembly according to authorities having jurisdiction and the device's reference standard.
- B. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.

3.5 ADJUSTING

- A. Set field-adjustable temperature set points of temperature-actuated, water mixing valves.

END OF SECTION

SECTION 221313 - FACILITY SANITARY SEWERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Hub-and-spigot, cast-iron soil pipe and fittings.
 - 2. Hubless cast-iron soil pipe and fittings.
 - 3. Ductile-iron, gravity sewer pipe and fittings.
 - 4. PVC pipe and fittings.
 - 5. Concrete pipe and fittings.
 - 6. Nonpressure-type transition couplings.
 - 7. Expansion joints and deflection fittings.
 - 8. Encasement for piping.
 - 9. Manholes.
 - 10. Concrete.

1.3 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Product Data: For the following:
 - 1. Pipe and fittings.
 - 2. Non-pressure couplings
- C. Shop Drawings: For manholes. Include plans, elevations, sections, details, and frames and covers.

1.4 INFORMATIONAL SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Product Certificates: For each type of pipe and fitting.
- C. Field quality-control reports.

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1.5 DELIVERY, STORAGE, AND HANDLING

- A. Do not store plastic manholes, pipe, and fittings in direct sunlight.
- B. Protect pipe, pipe fittings, and seals from dirt and damage.
- C. Handle manholes according to manufacturer's written rigging instructions.

1.6 FIELD CONDITIONS

- A. Interruption of Existing Sanitary Sewerage 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 Architect and Owner no fewer than five days in advance of proposed interruption of service.
 - 2. Do not proceed with interruption of service without Owner's written permission.

PART 2 - PRODUCTS

2.1 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 74, Service and Extra-Heavy classes.
- B. Gaskets: ASTM C 564, rubber.
- C. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

2.2 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 888 or CISPI 301.
- B. Cast-Iron, Shielded Couplings:
 - 1. Description: ASTM C 1277 with ASTM A 48/A 48M, two-piece, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, rubber sleeve with integral, center pipe stop.
 - 2. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [ANACO-Husky.](#)
 - b. [Charlotte Pipe and Foundry Company.](#)
 - c. [Clamp-All Corp.](#)
 - d. [Dallas Specialty & Mfg. Co.](#)
 - e. [MG Piping Products Company.](#)

- f. [Mission Rubber Company, LLC; a division of MCP Industries.](#)
- g. [Tyler Pipe; a subsidiary of McWane Inc.](#)

2.3 DUCTILE-IRON, GRAVITY SEWER PIPE AND FITTINGS

- A. Pipe: ASTM A 746, for push-on joints.
- B. Standard Fittings: AWWA C110/A21.10, ductile or gray iron, for push-on joints.
- C. Compact Fittings: AWWA C153/A21.53, ductile iron, for push-on joints.
- D. Gaskets: AWWA C111/A21.11, rubber.

2.4 PVC PIPE AND FITTINGS

- A. PVC Type PSM Sewer Piping:
 - 1. Pipe: ASTM D 3034, SDR 35, PVC Type PSM sewer pipe with bell-and-spigot ends for gasketed joints.
 - 2. Fittings: ASTM D 3034, PVC with bell ends.
 - 3. Gaskets: ASTM F 477, elastomeric seals.

2.5 CONCRETE PIPE AND FITTINGS

- A. Reinforced-Concrete Sewer Pipe and Fittings: ASTM C 76.
 - 1. Bell-and-spigot ends for gasketed joints, with ASTM C 443, rubber gaskets.
 - 2. Class III, Wall A.

2.6 NONPRESSURE-TYPE TRANSITION COUPLINGS

- A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling; for joining underground nonpressure piping. Include ends of same sizes as piping to be joined and include corrosion-resistant-metal tension band and tightening mechanism on each end.
- B. Sleeve Materials:
 - 1. For Cast-Iron Soil Pipes: ASTM C 564, rubber.
 - 2. For Concrete Pipes: ASTM C 443, rubber.
 - 3. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
 - 4. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
- C. Shielded, Flexible Couplings:

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1. Description: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
2. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Cascade Waterworks Mfg. Co.
 - b. Dallas Specialty & Mfg. Co.
 - c. Mission Rubber Company, LLC; a division of MCP Industries.

D. Ring-Type, Flexible Couplings:

1. Description: Elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.
2. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Fernco Inc.
 - b. Logan Clay Pipe.
 - c. Mission Rubber Company, LLC; a division of MCP Industries.

2.7 ENCASEMENT FOR FERROUS PIPING

- A. Standard: ASTM A 674 or AWWA C105/A21.5.
- B. Material: Linear low-density polyethylene film of 0.008-inch or high-density, cross-laminated polyethylene film of 0.004-inch minimum thickness.
- C. Form: Tube.
- D. Color: Black.

2.8 MANHOLES

A. Standard Precast Concrete Manholes:

1. Description: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
2. Diameter: 48 inches minimum unless otherwise indicated.
3. Ballast: Increase thickness of precast concrete sections or add concrete to base section, as required to prevent flotation.
4. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section; with separate base slab or base section with integral floor.
5. Riser Sections: 4-inch minimum thickness, of length to provide depth indicated.

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6. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated; with top of cone of size that matches grade rings.
7. Joint Sealant: ASTM C 990, bitumen or butyl rubber.
8. Resilient Pipe Connectors: ASTM C 923, cast or fitted into manhole walls, for each pipe connection.
9. Steps: Individual FRP steps, FRP ladder, or ASTM A 615/A 615M, deformed, 1/2-inch steel reinforcing rods encased in ASTM D 4101, PP; wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches.
10. Adjusting Rings: Interlocking HDPE rings, with level or sloped edge in thickness and diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.
11. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, with diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope.

B. Manhole Frames and Covers:

1. Description: City of Portland standard ferrous; 24-inch ID by 7- to 9-inch riser, with 4-inch- minimum-width flange and 26-inch- diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "SANITARY SEWER."
2. Material: ASTM A 48/A 48M, Class 35 gray iron unless otherwise indicated.

2.9 CONCRETE

A. General: Cast-in-place concrete complying with ACI 318, ACI 350, and the following:

1. Cement: ASTM C 150/C 150M, Type II.
2. Fine Aggregate: ASTM C 33/C 33M, sand.
3. Coarse Aggregate: ASTM C 33/C 33M, crushed gravel.
4. Water: Potable.

B. Portland Cement Design Mix: 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio.

1. Reinforcing Fabric: ASTM A 1064/A 1064M, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 deformed steel.

C. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.

1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.
 - a. Invert Slope: 2 percent through manhole.

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2. Benches: Concrete, sloped to drain into channel.

a. Slope: 8 percent.

D. Ballast and Pipe Supports: Portland cement design mix, 3000 psi minimum, with 0.58 maximum water/cementitious materials ratio.

1. Reinforcing Fabric: ASTM A1064/A 1064M, steel, welded wire fabric, plain.

2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 deformed steel.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Section 312000 "Earth Moving."

3.2 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details to indicate general location and arrangement of underground sanitary sewer piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.

C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.

D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

E. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.

F. Install gravity-flow, nonpressure, drainage piping according to the following:

1. Install piping pitched down in direction of flow, at minimum slope of 0.5 percent unless otherwise indicated.

2. Install piping as indicated.

3. Install hub-and-spigot, cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook."

4. Install hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook."

5. Install ductile-iron, gravity sewer piping according to ASTM A 746.

6. Install PVC Type PSM sewer piping according to ASTM D 2321 and ASTM F 1668.
 7. Install reinforced-concrete sewer piping according to ASTM C 1479 and ACPA's "Concrete Pipe Installation Manual."
- G. Install corrosion-protection piping encasement over the following underground metal piping according to ASTM A 674 or AWWA C105/A21.5:
1. Hub-and-spigot, cast-iron soil pipe.
 2. Hubless cast-iron soil pipe and fittings.
 3. Ductile-iron pipe and fittings.
- H. Clear interior of piping and manholes of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

3.3 PIPE JOINT CONSTRUCTION

- A. Join gravity-flow, nonpressure, drainage piping according to the following:
1. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
 2. Join hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.
 3. Join ductile-iron, gravity sewer piping according to AWWA C600 for push-on joints.
 4. Join PVC Type PSM sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasket joints.
 5. Join reinforced-concrete sewer piping according to ACPA's "Concrete Pipe Installation Manual" for rubber-gasket joints.
 6. Join dissimilar pipe materials with nonpressure-type, flexible couplings.
- B. Pipe couplings, expansion joints, and deflection fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
1. Use nonpressure flexible couplings where required to join gravity-flow, nonpressure sewer piping unless otherwise indicated.
 - a. Shielded flexible couplings for pipes of same or slightly different OD.
 - b. Unshielded, increaser/reducer-pattern, flexible couplings for pipes with different OD.
 - c. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.

3.4 MANHOLE INSTALLATION

- A. General: Install manholes complete with appurtenances and accessories indicated.
- B. Install precast concrete manhole sections with sealants according to ASTM C 891.

- C. Form continuous concrete channels and benches between inlets and outlet.
- D. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 2 inches above finished surface elsewhere unless otherwise indicated.
- E. Install manhole-cover inserts in frame and immediately below cover.

3.5 CONCRETE PLACEMENT

- A. Place cast-in-place concrete according to ACI 318.

3.6 CONNECTIONS

- A. Connect nonpressure, gravity-flow drainage piping to building's sanitary building drains specified in Section 221316 "Sanitary Waste and Vent Piping."
- B. Make connections to existing piping and underground manholes.
 - 1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye fitting plus 6-inch overlap with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
 - 2. Make branch connections from side into existing piping, NPS 4 to NPS 20. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
 - 3. Make branch connections to underground manholes by cutting opening into existing unit large enough to allow 3 inches of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of, and be flush with, inside wall unless otherwise indicated. On outside of pipe or manhole wall, encase entering connection in 6 inches of concrete for minimum length of 12 inches to provide additional support of collar from connection to undisturbed ground.
 - a. Use concrete that will attain a minimum 28-day compressive strength of 3000 psi unless otherwise indicated.
 - b. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.
 - 4. Protect existing piping and manholes to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.
- C. Connect to grease interceptors specified in Section 221323 "Sanitary Waste Interceptors."

3.7 CLOSING ABANDONED SANITARY SEWER SYSTEMS

- A. Abandon sewer systems according to Section 024119 "Selective Demolition."

- B. Backfill to grade according to Section 312000 "Earth Moving."

3.8 IDENTIFICATION

- A. Comply with requirements in Section 312000 "Earth Moving" for underground utility identification devices. Arrange for installation of green warning tapes directly over piping and at outside edges of underground manholes.
 - 1. Use detectable warning tape over piping and over edges of underground manholes.

3.9 FIELD QUALITY CONTROL

- A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.
 - 1. Notify City of Portland Department of Public Services at least 48 hours prior to backfilling to allow for inspection of piping systems.
 - 2. Submit separate report for each system inspection.
 - 3. Defects requiring correction include the following:
 - a. Alignment: Less than full diameter of inside of pipe is visible between structures.
 - b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
 - c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
 - d. Infiltration: Water leakage into piping.
 - e. Exfiltration: Water leakage from or around piping.
 - 4. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
 - 5. Reinspect and repeat procedure until results are satisfactory.
- B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
 - 1. Do not enclose, cover, or put into service before inspection and approval.
 - 2. Test completed piping systems according to requirements of authorities having jurisdiction.
 - 3. Schedule tests and inspections by authorities having jurisdiction with at least 48 hours' advance notice.
 - 4. Submit separate report for each test.
 - 5. Hydrostatic Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction and the following:
 - a. Fill sewer piping with water. Test with pressure of at least 10-foot head of water, and maintain such pressure without leakage for at least 15 minutes.
 - b. Close openings in system and fill with water.
 - c. Purge air and refill with water.
 - d. Disconnect water supply.

- e. Test and inspect joints for leaks.
- 6. Air Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
 - a. Test plastic gravity sewer piping according to ASTM F 1417.
 - b. Test concrete gravity sewer piping according to ASTM C 1628.
- 7. Manholes: Perform hydraulic test according to ASTM C 969.
- C. Leaks and loss in test pressure constitute defects that must be repaired.
- D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

3.10 CLEANING

- A. Clean dirt and superfluous material from interior of piping. Flush with water.

END OF SECTION

SECTION 221316 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

- 1. Pipe, tube, and fittings.
- 2. Specialty pipe fittings.

B. Related Requirements:

- 1. Section 221313 "Facility Sanitary Sewers" for sanitary sewerage piping and structures outside the building.
- 2. Section 221429 "Sump Pumps" for submersible sump pumps.

- C. Sustainable Design Requirements: Work included in this specification shall conform to the US Green Building Council LEED requirements listed in Section 018113.23 "Sustainable Design Requirements - LEED 2009 for Schools."

1.3 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Product Data: For each type of product. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.
- C. Piping Schedule: Identify type of material, fittings and joining method to be used for each piping application and size range.
- D. Provide piping layouts, including pipe size and insulation requirements to General Contractor for inclusion in project coordination drawings.
- E. Sustainable Design Submittals:
 - 1. Product Data: For adhesives, indicating VOC content.
 - 2. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.

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1.4 INFORMATIONAL SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Field quality-control reports.

1.5 FIELD CONDITIONS

- A. Interruption of Existing Sanitary Waste 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 Owner no fewer than seven days in advance of proposed interruption of sanitary waste service.
 - 2. Do not proceed with interruption of sanitary waste service without Owner's written permission.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
 - 1. Soil, Waste, and Vent Piping: 10-foot head of water.
 - 2. Waste, Force-Main Piping: 50 psig.

2.2 PIPING MATERIALS

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. 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.

2.3 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 888 or CISPI 301.
- B. Heavy-Duty, Hubless-Piping Couplings:
 - 1. Standards: ASTM C 1277 and ASTM C 1540.
 - 2. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.4 GALVANIZED-STEEL PIPE AND FITTINGS

- A. Galvanized-Steel Pipe: ASTM A 53/A 53M, Type E, Standard Weight class. Include square-cut-grooved or threaded ends matching jointing method.
- B. Steel Pipe Pressure Fittings:
 - 1. Galvanized-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106/A 106M, Schedule 40, seamless steel pipe. Include ends matching joining method.
 - 2. Malleable-Iron Unions: ASME B16.39; Class 150; hexagonal-stock body with ball-and-socket, metal-to-metal, bronze seating surface; and female threaded ends.
 - 3. Galvanized-Gray-Iron, Threaded Fittings: ASTM B16.4, Class 125, standard pattern.

2.5 COPPER TUBE AND FITTINGS

- A. Copper Type DWV Tube: ASTM B 306, drainage tube, drawn temper.
- B. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.
- C. Solder: ASTM B 32, lead free with ASTM B 813, water-flushable flux.

2.6 PVC PIPE AND FITTINGS

- A. 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 and "NSF-sewer" for plastic sewer piping.
- B. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.
- C. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
- D. Adhesive Primer: ASTM F 656.
 - 1. Adhesive primer shall have a VOC content of 550 g/L or less.
- E. Solvent Cement: ASTM D 2564.
 - 1. Solvent cement shall have a VOC content of 510 g/L or less.

2.7 SPECIALTY PIPE FITTINGS

- A. Transition Couplings:
 - 1. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
 - 2. Unshielded, Nonpressure Transition Couplings:

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- a. Standard: ASTM C 1173.
- b. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
- c. End Connections: Same size as and compatible with pipes to be joined.
- d. Sleeve Materials:
 - 1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
 - 2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
 - 3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

PART 3 - EXECUTION

3.1 EARTH MOVING

- A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 "Earth Moving."

3.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams and diagrammatic in nature and indicate general location and arrangement of piping systems.
 1. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.
 2. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.
- F. Install piping at indicated slopes.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Install piping to allow application of insulation.

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- J. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends.
 - 1. 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.
 - 2. 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.
 - a. Straight tees, elbows, and crosses may be used on vent lines.
 - 3. Do not change direction of flow more than 90 degrees.
 - 4. Use proper size of standard increasers and reducers if pipes of different sizes are connected.
 - a. Reducing size of waste piping in direction of flow is prohibited.
- K. Lay buried building waste piping beginning at low point of each system.
 - 1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
 - 2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
 - 3. Maintain swab in piping and pull past each joint as completed.
- L. Install soil and waste and vent piping at the following minimum slopes unless otherwise indicated:
 - 1. Building Sanitary Waste: 2 percent downward in direction of flow.
 - 2. Horizontal Sanitary Waste Piping: 2 percent downward in direction of flow.
 - 3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.
- M. 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."
 - 1. Install encasement on underground piping according to ASTM A 674 or AWWA C105/A 21.5.
- N. Install steel piping according to applicable plumbing code.
- O. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."
- P. Install aboveground PVC piping according to ASTM D 2665.
- Q. Install underground PVC piping according to ASTM D 2321.
- R. Plumbing Specialties:
 - 1. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary waste gravity-flow piping.

- a. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping.
 - b. Comply with requirements for cleanouts specified in Section 221319 "Sanitary Waste Piping Specialties."
2. Install drains in sanitary waste gravity-flow piping.
- a. Comply with requirements for drains specified in Section 221319 "Sanitary Waste Piping Specialties."
- S. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- T. Install sleeves for piping penetrations of walls, ceilings, and floors.
1. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- U. Install sleeve seals for piping penetrations of concrete walls and slabs.
1. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- V. Install escutcheons for piping penetrations of walls, ceilings, and floors.
1. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.3 JOINT CONSTRUCTION

- A. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.
- B. Ream ends of pipes and tubes and remove burrs.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1.
 1. Cut threads full and clean using sharp dies.
 2. 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.
 - c. Do not use pipe sections that have cracked or open welds.

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- E. Join copper tube and fittings with soldered joints according to ASTM B 828. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.
- F. Plastic, Nonpressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 - 2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 appendixes.
 - 3. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 appendixes.
- G. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

3.4 SPECIALTY PIPE FITTING INSTALLATION

- A. Transition Couplings:
 - 1. Install transition couplings at joints of piping with small differences in ODs.

3.5 VALVE INSTALLATION

- A. Comply with requirements in Section 220523.12 "Ball Valves for Plumbing Piping" and Section 220523.14 "Check Valves for Plumbing Piping," for general-duty valve installation requirements.
- B. Shutoff Valves:
 - 1. Install shutoff valve on each sump pump discharge.
 - 2. Install gate or full-port ball valve for piping NPS 2 and smaller.
- C. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.

3.6 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- B. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
- C. Support horizontal piping and tubing within 12 inches 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 minimum rods.

- F. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
 - 2. NPS 3: 60 inches with 1/2-inch rod.
 - 3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
 - 4. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.
 - 5. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.
- G. Install supports for vertical cast-iron soil piping every 15 feet.
- H. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/4: 84 inches with 3/8-inch rod.
 - 2. NPS 1-1/2: 108 inches with 3/8-inch rod.
 - 3. NPS 2: 10 feet with 3/8-inch rod.
- I. Install supports for vertical steel piping every 10 feet.
- J. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/4: 72 inches with 3/8-inch rod.
 - 2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
 - 3. NPS 2-1/2: 108 inches with 1/2-inch rod.
- K. Install supports for vertical copper tubing every 10 feet.
- L. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/2 and NPS 2: 48 inches with 3/8-inch rod.
 - 2. NPS 3: 48 inches with 1/2-inch rod.
 - 3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
 - 4. NPS 6 and NPS 8: 48 inches with 3/4-inch rod.
- M. Install supports for vertical PVC piping every 48 inches.
- N. Support piping and tubing not listed above according to MSS SP-58 and manufacturer's written instructions.

3.7 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

- C. Connect waste and vent piping to the following:
1. Plumbing Fixtures: Connect waste piping in sizes indicated, but not smaller than required by plumbing code.
 2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
 3. Plumbing Specialties: Connect waste and vent piping in sizes indicated, but not smaller than required by plumbing code.
 4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
 5. Equipment: Connect waste piping as indicated.
 - a. Provide shutoff valve if indicated and union for each connection.
 - b. Use flanges instead of unions for connections NPS 2-1/2 and larger.
- D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

3.8 IDENTIFICATION

- A. Identify exposed sanitary waste and vent piping.
- B. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.9 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 72 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test sanitary waste and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.
 - a. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

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2. Leave uncovered and unconcealed new, altered, extended, or replaced waste and vent piping until it has been tested and approved.
 - a. Expose work that was covered or concealed before it was tested.
 3. Roughing-in Plumbing Test Procedure: Test waste and vent piping except outside leaders on completion of roughing-in.
 - a. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water.
 - b. From 15 minutes before inspection starts to completion of inspection, water level must not drop.
 - c. Inspect joints for leaks.
 4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight.
 - a. 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.
 - b. Use U-tube or manometer inserted in trap of water closet to measure this pressure.
 - c. Air pressure must remain constant without introducing additional air throughout period of inspection.
 - d. Inspect plumbing fixture connections for gas and water leaks.
 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 required corrective action.
- E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved.
 - a. Expose work that was covered or concealed before it was tested.
 2. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials.
 - a. Isolate test source and allow to stand for four hours.
 - b. Leaks and loss in test pressure constitute defects that must be repaired.
 3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 4. Prepare reports for tests and required corrective action.

3.10 CLEANING AND PROTECTION

- A. Clean interior of piping. Remove dirt and debris as work progresses.

- B. Protect sanitary waste and vent piping during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.
- D. Exposed PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.
- E. Repair damage to adjacent materials caused by waste and vent piping installation.

3.11 PIPING SCHEDULE

- A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
- B. Aboveground, soil and waste piping shall be the following:
 - 1. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.
- C. Aboveground, vent piping shall be the following:
 - 1. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.
- D. Underground, soil, waste, and vent piping shall be the following:
 - 1. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.
 - 2. Solid-Wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 - 3. Dissimilar Pipe-Material Couplings: , nonpressure transition couplings.
- E. Aboveground sanitary-sewage force mains shall be the following:
 - 1. Galvanized-steel pipe, pressure fittings, and threaded joints.
- F. Aboveground indirect waste piping NPS 2 and smaller, except for gas-fired water heater drain lines, shall be the following:
 - 1. Copper type DWV tube, copper drainage fittings, and soldered joints.
- G. Condensate drain piping from condensing-type gas-fired plumbing equipment shall be the following:
 - 1. Solid-wall PVC pipe, PVC socket fittings, and solvent cemented joints.

END OF SECTION

SECTION 221319 - SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

- 1. Cleanouts.
- 2. Miscellaneous sanitary drainage piping specialties.

B. Related Requirements:

- 1. Section 221423 "Storm Drainage Piping Specialties" for roof drains.

1.3 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Product Data: For each type of product. Include rated capacities, operating characteristics, and accessories. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTIONS

- A. Sanitary waste piping specialties shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14 for plastic sanitary waste piping specialty components.

2.2 CLEANOUTS

A. Cast-Iron Exposed Cleanouts (CO):

- 1. Standard: ASME A112.36.2M.

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2. Size: Same as connected drainage piping
3. Body Material: As required to match connected piping.
4. Closure: Countersunk, brass plug.
5. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

B. Cast-Iron Exposed Floor Cleanouts (FCO):

1. Standard: ASME A112.36.2M.
2. Size: Same as connected branch.
3. Type: Threaded, adjustable housing.
4. Body or Ferrule: Cast iron.
5. Closure: Brass plug with tapered threads.
6. Adjustable Housing Material: Cast iron with threads.
7. Frame and Cover Material and Finish: Polished bronze.
8. Frame and Cover Shape: Round.
9. Top Loading Classification: Light Duty.
10. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

C. Cast-Iron Wall Cleanouts (WCO):

1. Standard: ASME A112.36.2M. Include wall access.
2. Size: Same as connected drainage piping.
3. Body: As required to match connected piping.
4. Closure Plug:
 - a. Brass.
 - b. Countersunk head.
 - c. Drilled and threaded for cover attachment screw.
 - d. Size: Same as or not more than one size smaller than cleanout size.
5. Wall Access: Round, flat, chrome-plated brass or stainless steel cover plate with screw.

2.3 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Deep-Seal Traps:

1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
2. Size: Same as connected waste piping.
 - a. NPS 2: 4-inch-minimum water seal.
 - b. NPS 2-1/2 and Larger: 5-inch-minimum water seal.

B. Floor-Drain, Trap-Seal Primer Fittings:

1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
2. Size: Same as floor drain outlet with NPS 1/2 side inlet.

C. Air-Gap Fittings:

1. Standard: ASTM A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
2. Body: Bronze or cast iron.
3. Inlet: Opening in top of body.
4. Outlet: Larger than inlet.
5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
 2. Locate at each change in direction of piping greater than 45 degrees.
 3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
 4. Locate at base of each vertical soil and waste stack.
- B. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- C. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- D. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof. Comply with requirements in Section 076200 "Sheet Metal Flashing and Trim."
- E. Install deep-seal traps on floor drains and other waste outlets, if indicated.
- F. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
 2. Size: Same as floor drain inlet.
- G. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.
- H. Install sleeve and sleeve seals with each riser and stack passing through floors with waterproof membrane.

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- I. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

3.2 CONNECTIONS

- A. Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.

3.3 FLASHING INSTALLATION

- A. Flashing shall be provided by Section 076200 "Sheet Metal Flashing and Trim."

3.4 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION

SECTION 221319.13 - SANITARY DRAINS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Floor drains.
 - 2. Shower drains.
 - 3. Floor sinks.

1.3 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Product Data: For each type of product. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.

PART 2 - PRODUCTS

2.1 DRAIN ASSEMBLIES

- A. Sanitary drains shall bear label, stamp, or other markings of specified testing agency.

2.2 FLOOR DRAINS

- A. Cast-Iron Floor Drains (FD):
 - 1. **Basis-of-Design Product:** Subject to compliance with requirements, provide Zurn Industries, LLC's product scheduled on Drawings. Substitutions shall not be accepted.
 - 2. Standard: ASME A112.6.3.
 - 3. Pattern: Floor drain.
 - 4. Body Material: Gray iron.
 - 5. Anchor Flange: Required.
 - 6. Clamping Device: Not required.
 - 7. Outlet: Bottom.

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8. Sediment Bucket: Provide where scheduled on Drawings.
9. Top or Strainer Material: Nickel bronze.
10. Top Shape: As scheduled on Drawings.
11. Dimensions of Top or Strainer: As scheduled on Drawings.
12. Top Loading Classification: Light Duty.
13. Funnel: As scheduled on Drawings.
14. Trap Pattern: Standard P-trap unless otherwise noted on Drawings.
15. Trap Features: Trap-seal primer valve drain connection.

2.3 SHOWER DRAINS

A. Cast-Iron Shower Drains (SH):

1. **Basis-of-Design Product:** Subject to compliance with requirements, provide Zurn Industries, LLC's product scheduled on Drawings or comparable product by one of the following:
 - a. **Josam Company.**
 - b. **MIFAB, Inc.**
 - c. Smith, Jay R. Mfg. Co.
 - d. Tyler Pipe; a subsidiary of McWane Inc.
 - e. Watts; a Watts Water Technologies company.
2. Standard: ASME A112.6.3.
3. Pattern: Floor drain.
4. Body Material: Gray iron.
5. Anchor Flange: Required.
6. Clamping Device: Not required.
7. Outlet: Bottom.
8. Sediment Bucket: Not required.
9. Top or Strainer Material: Stainless steel.
10. Top Shape: Round.
11. Dimensions of Top or Strainer: As scheduled on Drawings.
12. Top Loading Classification: Light Duty.
13. Trap Features: Trap-seal primer valve drain connection.

2.4 FLOOR SINKS

A. Cast-Iron Floor Sinks (FS):

1. **Basis-of-Design Product:** Subject to compliance with requirements, provide Zurn Industries, LLC's product scheduled on Drawings or comparable product by one of the following:
 - a. **Josam Company.**
 - b. **MIFAB, Inc.**
 - c. Smith, Jay R. Mfg. Co.
 - d. Tyler Pipe; a subsidiary of McWane Inc.

- e. Watts; a Watts Water Technologies company.
- 2. Standard: ASME A112.6.3.
- 3. Pattern: Floor sink.
- 4. Body Material: Gray iron.
- 5. Anchor Flange: Required.
- 6. Clamping Device: Not required.
- 7. Outlet: Bottom.
- 8. Coating on Interior and Exposed Exterior Surfaces: Acid-resistant enamel.
- 9. Sediment Bucket: Provide where scheduled on Drawings.
- 10. Top or Strainer Material: Nickel bronze.
- 11. Top Shape: Square with partial grates as scheduled on Drawings.
- 12. Dimensions of Top or Strainer: As scheduled on Drawings.
- 13. Top Loading Classification: Light Duty.
- 14. Trap Features: Trap-seal primer valve drain connection.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install floor drains, floor sinks, and shower drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
 - 1. Position drains for easy access and maintenance.
 - 2. Set floor drains and floor sinks below elevation of surrounding finished floor to allow floor drainage.
 - 3. Set with grates depressed according to the following drainage area radii:
 - a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
 - b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
 - c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.
 - 4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

3.2 CONNECTIONS

- A. Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Comply with requirements in Section 221313 "Facility Sanitary Sewers" for grease interceptors.
- C. Install piping adjacent to equipment to allow service and maintenance.

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3.3 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION

SECTION 221413 - STORM DRAINAGE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Pipe, tube, and fittings.
- 2. Specialty pipe fittings.
- 3. Encasement for underground metal piping.

- B. Related Sections:

- 1. Section 221429 "Sump Pumps" for storm drainage pumps.
- 2. Section 334100 "Facility Storm Utility Drainage Piping" for storm drainage piping outside the building.

- C. Sustainable Design Requirements: Work included in this specification shall conform to the US Green Building Council LEED requirements listed in Section 018113.23 "Sustainable Design Requirements - LEED 2009 for Schools."

1.3 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:

- 1. Storm Drainage Piping: 10-foot head of water.

1.4 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.

- B. Product Data: For each type of product indicated. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.

- C. Piping Schedule: Identify type of material, fittings and joining method to be used for each piping application and size range.

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- D. Provide piping layouts, including pipe size and insulation requirements to General Contractor for inclusion in project coordination drawings.
- E. Sustainable Design Submittals:
 - 1. **Product Data:** For adhesives, indicating VOC content.
 - 2. **Laboratory Test Reports:** For adhesives, indicating compliance with requirements for low-emitting materials.

1.5 INFORMATIONAL SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Field quality-control reports.

1.6 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF/ANSI 14, "Plastics Piping System Components and Related Materials," for plastic piping components. Include marking with "NSF-drain" for plastic drain piping and "NSF-sewer" for plastic sewer piping.

1.7 PROJECT CONDITIONS

- A. 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 Owner no fewer than seven days in advance of proposed interruption of storm-drainage service.
 - 2. Do not proceed with interruption of storm-drainage service without Owner's written permission.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. 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.

2.2 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 888 or CISPI 301.

B. CISPI, Hubless-Piping Couplings:

1. Standards: ASTM C 1277 and CISPI 310.
2. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.3 PVC PIPE AND FITTINGS

A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.

B. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

C. Adhesive Primer: ASTM F 656.

1. Adhesive primer shall have a VOC content of 550 g/L or less.
2. Adhesive primer 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."

D. Solvent Cement: ASTM D 2564.

1. Solvent cement shall have a VOC content of 510 g/L or less.
2. Adhesive 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."

2.4 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. General Requirements: Fitting or device for joining piping with small differences in ODs or of different materials. Include end connections same size as and compatible with pipes to be joined.
2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified-piping-system fitting.
3. Unshielded, Nonpressure Transition Couplings:
 - a. Standard: ASTM C 1173.
 - b. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - c. Sleeve Materials:
 - 1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
 - 2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.

- 3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

PART 3 - EXECUTION

3.1 EARTH MOVING

- A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 "Earth Moving."

3.2 PIPING INSTALLATION

- A. 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 from layout are approved on coordination drawings.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.
- F. Install piping at indicated slopes.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Install piping to allow application of insulation.
- J. Make changes in direction for storm drainage piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- K. Lay buried building storm drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
- L. Install storm drainage piping at the following minimum slopes unless otherwise indicated:

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1. Building Storm Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
 2. Horizontal Branch Storm Drain: 2 percent downward in direction of flow unless otherwise indicated on plans.
- M. 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."
- N. Install underground PVC piping according to ASTM D 2321.
- O. Plumbing Specialties:
1. Install cleanouts at floor or grade and extend to where building storm drains connect to building storm sewers in storm drainage gravity-flow piping. Comply with requirements for cleanouts specified in Section 221423 "Storm Drainage Piping Specialties."
 2. Install drains in storm drainage gravity-flow piping. Comply with requirements for drains specified in Section 221423 "Storm Drainage Piping Specialties."
- P. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- Q. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- R. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- S. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."
- 3.3 JOINT CONSTRUCTION
- A. Hubless, Cast-Iron Soil Piping Coupled Joints: Join according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.
- B. Plastic, Nonpressure-Piping, Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 2. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendices.
- 3.4 SPECIALTY PIPE FITTING INSTALLATION
- A. Transition Couplings:
1. Install transition couplings at joints of piping with small differences in ODs.

2. In Drainage Piping: Shielded, nonpressure transition couplings.

3.5 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
 1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
 2. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
 3. Vertical Piping: MSS Type 8 or Type 42, clamps.
 4. Individual, Straight, Horizontal Piping Runs:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
 5. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 6. Base of Vertical Piping: MSS Type 52, spring hangers.
- B. Support horizontal piping and tubing within 12 inches of each fitting[, **valve,**] and coupling.
- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.
- E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
 1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
 2. NPS 3: 60 inches with 1/2-inch rod.
 3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
 4. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.
 5. Spacing for 10-foot pipe lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.
- F. Install supports for vertical cast-iron soil piping every 15 feet.
- G. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.6 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect storm drainage piping to roof drains and storm drainage specialties.

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1. Install test tees (wall cleanouts) in conductors near floor, and floor cleanouts with cover flush with floor.
 2. Comply with requirements specified in Section 221423 "Storm Drainage Piping Specialties."
- D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

3.7 IDENTIFICATION

- A. Identify exposed storm drainage piping. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.8 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 72 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test storm drainage piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
1. 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.
 2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 3. Test Procedure: Test storm drainage 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. From 15 minutes before inspection starts until completion of inspection, water level must not drop. Inspect joints for leaks.
 4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 5. Prepare reports for tests and required corrective action.

3.9 CLEANING

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.10 PIPING SCHEDULE

- A. Aboveground storm drainage piping shall be the following:
 - 1. Hubless, cast-iron soil pipe and fittings; CISPI, hubless-piping couplings; and coupled joints.
- B. Underground storm drainage piping shall be the following:
 - 1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

END OF SECTION

SECTION 221423 - STORM DRAINAGE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Roof drains.
- 2. Cleanouts.

1.3 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Product Data: For each type of product indicated. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.
- C. Provide drain cutsheets, including dimensions, to General Contractor for inclusion in project coordination drawings.

1.4 QUALITY ASSURANCE

- A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.1 METAL ROOF DRAINS

- A. Cast-Iron, Medium-Sump, General-Purpose, Dual, Roof Drains (RD-1):

- 1. **Basis-of-Design Product:** Subject to compliance with requirements, provide Zurn Plumbing Products Group product scheduled on drawings or comparable product by available manufacturers offering products that may be incorporated into the Work which include, but are not limited to, the following:

- a. **Josam Company.**
 - b. **MIFAB, Inc.**
 - c. **Smith, Jay R. Mfg. Co.**
 - d. **Tyler Pipe.**
 - e. **Watts; a Watts Water Technologies company.**
2. Description: Combination of separate roof drain and overflow drain with a single, common, double deck plate.
 3. Body Material: Cast iron.
 4. Dimension of Body: 12-inch diameter.
 5. Combination Flashing Ring and Gravel Stop: Required.
 6. Outlet: Bottom.
 7. Extension Collars: Adjustable and static as required to suit roof insulation thickness.
 8. Dome Material: Aluminum or cast iron, 4 inches high minimum on each drain.

B. Cast-Iron, Medium-Sump, General-Purpose Roof Drains (RD-2):

1. **Basis-of-Design Product:** Subject to compliance with requirements, provide Zurn Plumbing Products Group product scheduled on drawings or comparable product by available manufacturers offering products that may be incorporated into the Work which include, but are not limited to, the following:
 - a. **Josam Company.**
 - b. **MIFAB, Inc.**
 - c. **Smith, Jay R. Mfg. Co.**
 - d. **Tyler Pipe.**
 - e. **Watts; a Watts Water Technologies company.**
2. Standard: ASME A112.6.4, for general-purpose roof drains.
3. Body Material: Cast iron.
4. Dimension of Body: 12-inch diameter.
5. Combination Flashing Ring and Gravel Stop: Required.
6. Outlet: Bottom.
7. Extension Collars: Adjustable required to suit roof insulation thickness.
8. Underdeck Clamp: Required.
9. Dome Material: Aluminum or cast iron, 4 inches high minimum.

2.2 CLEANOUTS

A. Cast-Iron Exposed Floor Cleanouts (FCO):

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. **Jay R. Smith Mfg. Co.**
 - b. **Josam Company.**
 - c. **Tyler Pipe; a subsidiary of McWane Inc.**
 - d. **Watts; a Watts Water Technologies company.**

e. **Zurn Industries, LLC.**

2. Standard: ASME A112.36.2M, for threaded, adjustable housing cleanouts.
3. Size: Same as connected branch.
4. Type: Threaded, adjustable housing.
5. Body or Ferrule Material: Cast iron.
6. Clamping Device: Not required.
7. Closure: Bronze or brass plug.
8. Adjustable Housing Material: Cast iron with threads.
9. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.
10. Frame and Cover Shape: Round.
11. Top-Loading Classification: Light Duty.
12. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

B. Exposed Cleanouts (CO):

1. Standard: ASME A112.36.2M and ASTM A 74, ASTM A 888, or CISPI 301, for cleanout test tees.
2. Size: Same as connected drainage piping.
3. Body Material: Hub-and-spigot, cast-iron soil-pipe T-branch; hubless, cast-iron soil-pipe test tee; or PVC as required to match connected piping.
4. Closure Plug: Raised head, brass or plastic plug.
5. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

C. Wall Cleanouts (WCO):

1. Standard: ASME A112.36.2M, for cleanouts. Include wall access.
2. Size: Same as connected drainage piping.
3. Body Material: Hub-and-spigot, cast-iron soil-pipe T-branch, hubless; cast-iron soil-pipe test tee; or PVC as required to match connected piping.
4. Closure: Countersunk or raised-head, drilled-and-threaded brass or plastic plug.
5. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
6. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.

2.3 MISCELLANEOUS STORM DRAINAGE PIPING SPECIALTIES

A. Overflow System Downspout Nozzle (ODN):

1. Basis-of-Design Product: Subject to compliance with requirements, provide Zurn Plumbing Products Group product scheduled on Drawings, or a comparable product by available manufacturers offering products that may be incorporated into the Work which include, but are not limited to, the following:
 - a. Josam Company.
 - b. Smith, Jay R. Mfg. Co.
 - c. Tyler Pipe/Wade Division.

2. Description: Wall-mounted downspout nozzle with nickel bronze body and decorative bronze wall flange with mounting holes. Nozzle shall be designed with integral spout to direct water away from the wall surface. Provide with removable nickel bronze or stainless steel screen over opening.
3. Size: Same as connected conductor indicated on Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions.
 1. Install flashing collar or flange of roof drain to prevent leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
 2. Position roof drains for easy access and maintenance.
- B. Install overflow system downspout nozzles at exposed ends of conduits where they spill onto grade.
- C. Install cleanouts in aboveground piping and building drain piping according to the following instructions unless otherwise indicated:
 1. Use cleanouts the same size as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
 2. Locate cleanouts at each change in direction of piping greater than 45 degrees.
 3. Locate cleanouts at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
 4. Locate cleanouts at base of each vertical storm drainage stack.
- D. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- E. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- F. Install exposed cleanouts in vertical conductors and near floor.
- G. Install wall cleanouts in vertical conductors. Install access door in wall if indicated.

3.2 CONNECTIONS

- A. Comply with requirements for piping specified in Section 221413 "Storm Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

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3.3 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION

SECTION 221429 - SUMP PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Submersible sump pumps.

1.3 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.
- C. Wiring Diagrams: For power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Operation and Maintenance Data: For pumps and controls, to include in operation and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Retain shipping flange protective covers and protective coatings during storage.
- B. Protect bearings and couplings against damage.
- C. Comply with pump manufacturer's written rigging instructions for handling.

PART 2 - PRODUCTS

2.1 SUBMERSIBLE SUMP PUMPS

A. Submersible, Fixed-Position, Single-Seal Oil-Minder Sump Pumps:

1. **Basis-of-Design Product:** Subject to compliance with requirements, provide Zoeller Company product indicated on Drawings or comparable product by one of the following:
 - a. Grundfos Pumps Corp.
 - b. Liberty Pumps.
 - c. Stancor, Inc.
 - d. Weil Pump Company, Inc.
2. Description: Factory-assembled and -tested sump-pump unit that allows water to be automatically pumped from the elevator pit, with controls to shut-down pump and alarm if it senses oil in the pit.
3. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sump pump as defined in HI 1.1-1.2 and HI 1.3.
4. Pump Casing: Cast iron, with strainer inlet, legs that elevate pump to permit flow into impeller, and vertical discharge for piping connection.
5. Impeller: Statically and dynamically balanced, ASTM A 48/A 48M, Class No. 25 A cast iron or ASTM B 584, cast bronze, design for clear wastewater handling, and keyed and secured to shaft.
6. Pump and Motor Shaft: Stainless steel, with factory-sealed, grease-lubricated ball bearings.
7. Seal: Mechanical.
8. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
 - a. Motor Housing Fluid: Oil.
9. Controls:
 - a. Enclosure: NEMA 250, Type 4X; wall-mounted.
 - b. Switch Type: Mechanical-float type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
 - c. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with mechanical-float, mercury-float, or pressure switch matching control and electric bell; 120-V

ac, with transformer and contacts for remote alarm bell. Include silence and test buttons and a float switch.

- d. Alarms, lights, silence switch, and remote monitoring circuit for oil, high liquid, high amperage, power to system, and pump activation.

10. Control-Interface Features:

- a. Remote Alarm Contacts: For remote alarm interface.
- b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:
 - 1) On-off status of pump.
 - 2) Alarm status.

2.2 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 220513 "Common Motor Requirements for Plumbing 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.
- B. Motors for submersible pumps shall be hermetically sealed.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Excavation and filling are specified in Section 312000 "Earth Moving."

3.2 INSTALLATION

- A. Pump Installation Standards: Comply with HI 1.4 for installation of sump pumps.

3.3 CONNECTIONS

- A. Comply with requirements for piping specified in Section 221413 "Storm Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.

3.4 FIELD QUALITY CONTROL

- A. Perform Tests and Inspections.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection.
2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Pumps and controls will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.5 STARTUP SERVICE

A. Perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

3.6 ADJUSTING

A. Adjust pumps to function smoothly, and lubricate as recommended by manufacturer.

B. Adjust control set points.

3.7 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain controls and pumps.

END OF SECTION

SECTION 223400 - FUEL-FIRED, DOMESTIC-WATER HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Commercial, gas-fired, high-efficiency, storage, domestic-water heaters.

- B. Sustainable Design Requirements: Work included in this specification shall conform to the US Green Building Council LEED requirements listed in Section 018113.23 "Sustainable Design Requirements - LEED 2009 for Schools."

1.3 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.

- B. Product Data: For each type and size of domestic-water heater indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.

- C. Sustainable Design Submittals:

- 1. Product Data: For energy efficiency.

- D. Shop Drawings:

- 1. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.

- B. Product Certificates: For each type of commercial, gas-fired, domestic-water heater, from manufacturer.

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- C. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.
- D. Source quality-control reports.
- E. Field quality-control reports.
- F. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Operation and Maintenance Data: For fuel-fired, domestic-water heaters to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE/IESNA Compliance: Fabricate and label fuel-fired, domestic-water heaters to comply with ASHRAE/IESNA 90.1.
 - 1. Comply with efficiency requirements in ASHRAE 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 Boiler and Pressure Vessel Code: Section VIII, Division 1.
 - 2. Where ASME-code construction is indicated, fabricate and label commercial, finned-tube, domestic-water heaters to comply with ASME Boiler and Pressure Vessel Code: Section IV.
- D. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61 Annex G, "Drinking Water System Components - Health Effects."

1.7 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of fuel-fired, domestic-water heaters that fail in materials or workmanship within specified warranty period.
1. Failures include, but are not limited to, the following:
 - a. Structural failures including storage tank and supports.
 - b. Faulty operation of controls.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal use.
 2. Warranty Periods: From date of Substantial Completion.
 - a. Commercial, Gas-Fired, Storage, Domestic-Water Heaters:
 - 1) Storage Tank: Five years.
 - 2) Controls and Other Components: Two years.

PART 2 - PRODUCTS

2.1 COMMERCIAL, GAS-FIRED, STORAGE, DOMESTIC-WATER HEATERS

- A. Direct-Vent, Gas-Fired, Storage, Domestic-Water Heaters:
1. **Basis-of-Design Product:** Subject to compliance with requirements, provide Heat Transfer Phoenix Model scheduled on Drawings or a comparable approved product.
 2. Description: Hot-water storage tank with integral heat-exchanger coil, direct-vent natural gas-fired burner, digital controls.
 3. Storage-Tank Construction: Stainless-steel.
 - a. Tappings: ASME B1.20.1 pipe thread.
 - b. Pressure Rating: 150 psig.
 - c. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending lining material into tappings.
 4. Factory-Installed Storage-Tank Appurtenances:
 - a. Anode Rod: Replaceable magnesium.
 - b. Drain Valve: ASSE 1005.
 - c. Insulation: Comply with ASHRAE/IESNA 90.1.
 - d. Jacket: Steel with enameled finish.
 - e. Heat-Trap Fittings: Inlet type in cold-water inlet and outlet type in hot-water outlet.
 - f. Burner: For use with direct-vent, gas-fired, domestic-water heaters and natural-gas fuel.
 - g. Temperature Control: Adjustable digital controller.

- h. Combination Temperature-and-Pressure Relief Valve: ANSI Z21.22/CSA 4.4-M. Include relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select relief valve with sensing element that extends into storage tank.
 - i. Factory-installed low-water cut-off.
 - j. Factory-installed upper hot water sensor and lower cold water sensor.
 - k. Factory-installed condensate trap assembly for extension to floor drain. Provide manufacturer's condensate neutralizing assembly for field installation.
5. Heat-Exchanger Coil: Cupronickel, copper, or stainless-steel coil assembly, permanently installed inside storage tank, for heating fluid. Include working-pressure rating equal to or greater than heating-fluid supply pressure.
6. Direct-Vent System: Provide manufacturer's concentric roof venting kit and associated accessories for solid core Schedule 40 CPVC venting.

2.2 DOMESTIC-WATER HEATER ACCESSORIES

A. Domestic-Water Compression Tanks:

1. **Basis-of-Design Product:** Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. [AMTROL Inc.](#)
 - b. [Smith, A. O. Water Products Co.; a division of A. O. Smith Corporation.](#)
 - c. [State Industries.](#)
 - d. [Taco, Inc.](#)
2. 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.
3. 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 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
 - c. Air-Charging Valve: Factory installed.
4. Capacity and Characteristics: As scheduled on the Drawings.

B. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1.

C. Heat-Trap Fittings: ASHRAE 90.2.

D. Gas Shutoff Valves: ANSI Z21.15/CSA 9.1-M, manually operated. Furnish for installation in piping.

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- E. Gas Pressure Regulators: ANSI Z21.18/CSA 6.3, appliance type. Include 1/2-psig pressure rating as required to match gas supply.
- F. Automatic Gas Valves: ANSI Z21.21/CSA 6.5, appliance, electrically operated, on-off automatic valve.
- G. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4-M.
- H. Outside Intake/Exhaust Venting Pipe: Solid core, Schedule 40 CPVC per ASTM F 441, with Schedule 40 CPVC socket fittings per ASTM F 438.
- I. 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 valve with sensing element that extends into storage tank.
 - 1. Gas-Fired, Domestic-Water Heaters: ANSI Z21.22/CSA 4.4-M.
- J. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4-M.

2.3 SOURCE QUALITY CONTROL

- A. Factory Tests: Test and inspect assembled domestic-water heaters and storage tanks specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.
- 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 Section 014000 "Quality Requirements" for retesting and reinspecting requirements and Section 017300 "Execution" for requirements for correcting the Work.
- D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 DOMESTIC-WATER HEATER INSTALLATION

- A. Commercial, Domestic-Water Heater Mounting: Install commercial domestic-water heaters on concrete base. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete" and Section 033053 "Miscellaneous Cast-in-Place Concrete."
 - 1. Maintain manufacturer's recommended clearances.
 - 2. Arrange units so controls and devices that require servicing are accessible.
 - 3. For supported equipment, install epoxy-coated anchor bolts that extend into structural concrete.
 - 4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

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5. Install anchor bolts to elevations required for proper attachment to supported equipment.
 6. Anchor domestic-water heaters to substrate.
- B. Install domestic-water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Section 220523.12 "Ball Valves for Plumbing Piping."
- C. Install gas-fired, domestic-water heaters according to NFPA 54.
1. Install gas shutoff valves on gas supply piping to gas-fired, domestic-water heaters without shutoff valves.
 2. Install gas pressure regulators on gas supplies to gas-fired, domestic-water heaters without gas pressure regulators if gas pressure regulators are required to reduce gas pressure at burner.
 3. Install automatic gas valves on gas supplies to gas-fired, domestic-water heaters if required for operation of safety control.
 4. Comply with requirements for gas shutoff valves, gas pressure regulators, and automatic gas valves specified in Section 231123 "Facility Natural-Gas Piping."
- D. 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.
- E. 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 221119 "Domestic Water Piping Specialties."
- F. Install thermometer on inlet and outlet piping of domestic-water heaters. Comply with requirements for thermometers specified in Section 220519 "Meters and Gages for Plumbing Piping."
- G. 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 220523.12 "Ball Valves for Plumbing Piping," and comply with requirements for thermometers specified in Section 220519 "Meters and Gages for Plumbing Piping."
- H. Fill domestic-water heaters with water.
- I. Charge domestic-water compression tanks with air.

3.2 CONNECTIONS

- A. Comply with requirements for domestic-water piping specified in Section 221116 "Domestic Water Piping."
- B. Comply with requirements for gas piping specified in Section 231123 "Facility Natural-Gas Piping."
- C. Drawings indicate general arrangement of piping, fittings, and specialties.
- D. Where installing piping adjacent to fuel-fired, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

3.3 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
 - 2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 014000 "Quality Requirements" for retesting and reinspecting requirements and Section 017300 "Execution" for requirements for correcting the Work.
- C. Prepare test and inspection reports.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain commercial, gas-fired, storage, domestic-water heaters.

END OF SECTION

SECTION 224213.13 - COMMERCIAL WATER CLOSETS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Water closets.
 - 2. Flushometer valves.
 - 3. Toilet seats.
 - 4. Supports.

1.3 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 from other drain line connections or fixture and where less than 1.5 drainage fixture units are upstream of the drain line connection.
- C. Sustainable Design Requirements: Work included in this specification shall conform to the US Green Building Council LEED requirements listed in Section 018113.23 "Sustainable Design Requirements - LEED 2009 for Schools."

1.4 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Product Data: For each type of product. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for water closets.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- C. Sustainable Design Submittals:
 - 1. Product Data: For water consumption.

1.5 CLOSEOUT SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 “Submittal Procedures” and the individual sections specifying the work.
- B. Operation and Maintenance Data: For flushometer valves to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 WALL-MOUNTED WATER CLOSETS

- A. Water Closets (WC-1, WC-2 and WC-3): Wall mounted, top spud, accessible.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Kohler Kingston Model K-4325 or a comparable product by one of the following:
 - a. American Standard America.
 - b. Crane Plumbing, L.L.C.
 - c. Zurn Industries, LLC.
 - 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. Rim Contour: Elongated.
 - f. Water Consumption: 1.28 gal. per flush.
 - g. Spud Size and Location: NPS 1-1/2; top.
 - 3. Flushometer Valve: WC.
 - 4. Toilet Seat: WC.
 - 5. Support: Water closet carrier.
 - 6. Water-Closet Mounting Height: Handicapped/elderly according to ICG/ANSI A 117.1 for WC-1; standard for WC-2; child accessible for WC-3.

2.2 FLUSHOMETER VALVES

- A. Lever-Handle, Diaphragm Flushometer Valves (WC):
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Sloan Royal Model 111-1.28 or a comparable product by the following:
 - a. Zurn Industries, LLC.
 - 2. Standard: ASSE 1037.
 - 3. Minimum Pressure Rating: 125 psig.

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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. Consumption: 1.28 gal. per flush, maximum.
8. Minimum Inlet: NPS 1.
9. Minimum Outlet: NPS 1-1/4.

2.3 TOILET SEATS

A. Toilet Seats (WC):

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Bemis Manufacturing Company.
 - b. Church Seats.
 - c. Olsonite Corp.
2. Standard: IAPMO/ANSI Z124.5.
3. Material: Plastic.
4. Type: Commercial (Heavy duty).
5. Shape: Elongated rim, open front.
6. Hinge: Check.
7. Hinge Material: Noncorroding metal.
8. Seat Cover: Not required.
9. Color: White.

2.4 SUPPORTS

A. Water Closet Carrier:

1. Standard: ASME A112.6.1M.
2. Description: Waste-fitting assembly, as required to match drainage piping material and arrangement with faceplates, couplings gaskets, and feet; bolts and hardware matching fixture.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before water-closet installation.
- B. Examine walls and floors for suitable conditions where water closets will be installed.

- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Water-Closet Installation:

1. Install level and plumb according to roughing-in drawings.
2. Install accessible, wall-mounted water closets at mounting height for handicapped/elderly, according to ICC/ANSI A117.1.

B. Support Installation:

1. Install supports, affixed to building substrate, for wall-mounted, back-outlet water closets.
2. Use carrier supports with waste-fitting assembly and seal.
3. Install wall-mounted, back-outlet water-closet supports with waste-fitting assembly and waste-fitting seals; and affix to building substrate.

C. Flushometer-Valve Installation:

1. Install flushometer-valve, water-supply fitting on each supply to each water closet.
2. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
3. Install lever-handle flushometer valves for accessible water closets with handle mounted on open side of water closet.
4. Install actuators in locations that are easy for children and people with disabilities to reach.

D. Install toilet seats on water closets.

E. Wall Flange and Escutcheon Installation:

1. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations and within cabinets and millwork.
2. Install deep-pattern escutcheons if required to conceal protruding fittings.
3. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."

F. Joint Sealing:

1. Seal joints between water closets and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
2. Match sealant color to water-closet color.
3. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

3.3 CONNECTIONS

- A. Connect water closets with water supplies and soil, waste, and vent piping. Use size fittings required to match water closets.

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- B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."
- D. Where installing piping adjacent to water closets, allow space for service and maintenance.

3.4 ADJUSTING

- A. Operate and adjust water closets and controls. Replace damaged and malfunctioning water closets, fittings, and controls.
- B. Adjust water pressure at flushometer valves to produce proper flow.

3.5 CLEANING AND PROTECTION

- A. Clean water closets and fittings with manufacturers' recommended cleaning methods and materials.
- B. Install protective covering for installed water closets and fittings.
- C. Do not allow use of water closets for temporary facilities unless approved in writing by Owner.

END OF SECTION

SECTION 224213.16 - COMMERCIAL URINALS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

- 1. Urinals.
- 2. Flushometer valves.
- 3. Supports.

B. Related Requirements:

- 1. Section 224600 "Security Plumbing Fixtures" for security urinals.

- C. Sustainable Design Requirements: Work included in this specification shall conform to the US Green Building Council LEED requirements listed in Section 018113.23 "Sustainable Design Requirements - LEED 2009 for Schools."

1.3 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.

- B. Product Data: For each type of product. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.

- 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for urinals.
- 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

C. Sustainable Design Submittals:

- 1. Product Data: For water consumption.

D. Shop Drawings:

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1.4 CLOSEOUT SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Operation and Maintenance Data: For flushometer valves to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 WALL-HUNG URINALS

- A. Urinals (U-1 and U-2): Wall hung, back outlet, washout, U-1 shall be accessible, U-2 shall be standard.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Kohler Bardon Model K-4991-ET or a comparable product by one of the following:
 - a. American Standard America.
 - b. Crane Plumbing, L.L.C.
 - c. Zurn Industries, LLC.
 - 2. Fixture:
 - a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
 - b. Material: Vitreous china.
 - c. Type: Washout with extended shields.
 - d. Strainer or Trapway: Open trapway with integral trap.
 - e. Water Consumption: Water saving, 0.125 gal. per flush.
 - f. Spud Size and Location: NPS 1-1/4; top.
 - g. Outlet Size and Location: NPS 2; back.
 - h. Color: White.
 - 3. Flushometer Valve: U-1/U-2.
 - 4. Waste Fitting:
 - a. Standard: ASME A112.18.2/CSA B125.2 for coupling.
 - b. Size: NPS 2.
 - 5. Support: 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: Handicapped/elderly according to ICC A 117.1 for U-1; standard for U-2.

2.2 URINAL FLUSHOMETER VALVES

- A. Lever-Handle, Diaphragm Flushometer Valves (U-1/U-2):

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1. Basis-of-Design Product: Subject to compliance with requirements, provide Sloan Royal Model 186-0125 W/H 735 or a comparable product by the following:
 - a. Zurn Industries, LLC.
2. Standard: ASSE 1037.
3. Minimum Pressure Rating: 125 psig.
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. Consumption: 0.125 gal. per flush.
8. Minimum Inlet: NPS 3/4.

2.3 SUPPORTS

- A. Type I Urinal Carrier:
 1. Standard: ASME A112.6.1M.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before urinal installation.
- B. Examine walls and floors for suitable conditions where urinals will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Urinal Installation:
 1. Install urinals level and plumb according to roughing-in drawings.
 2. Install accessible, wall-mounted urinals at mounting height for the handicapped/elderly, according to ICC/ANSI A117.1 where indicated.
- B. Support Installation:
 1. Install supports, affixed to building substrate, for wall-hung urinals.
 2. Use off-floor carriers with waste fitting and seal for back-outlet urinals.
 3. Use chair-type carrier supports with rectangular steel uprights.
- C. Flushometer-Valve Installation:
 1. Install flushometer-valve water-supply fitting on each supply to each urinal.

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2. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
3. Install lever-handle flushometer valves for accessible urinals with handle mounted on open side of compartment.

D. Wall Flange and Escutcheon Installation:

1. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations.
2. Install deep-pattern escutcheons if required to conceal protruding fittings.
3. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."

E. Joint Sealing:

1. Seal joints between urinals and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
2. Match sealant color to urinal color.
3. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

3.3 CONNECTIONS

- A. Connect urinals with water supplies and soil, waste, and vent piping. Use size fittings required to match urinals.
- B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."
- D. Where installing piping adjacent to urinals, allow space for service and maintenance.

3.4 ADJUSTING

- A. Operate and adjust urinals and controls. Replace damaged and malfunctioning urinals, fittings, and controls.
- B. Adjust water pressure at flushometer valves to produce proper flow.

3.5 CLEANING AND PROTECTION

- A. Clean urinals and fittings with manufacturers' recommended cleaning methods and materials.
- B. Install protective covering for installed urinals and fittings.
- C. Do not allow use of urinals for temporary facilities unless approved in writing by Owner.

END OF SECTION

SECTION 224216.13 - COMMERCIAL LAVATORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Lavatories.
 - 2. Faucets.
 - 3. Supports.
- B. Sustainable Design Requirements: Work included in this specification shall conform to the US Green Building Council LEED requirements listed in Section 018113.23 "Sustainable Design Requirements - LEED 2009 for Schools."

1.3 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Product Data: For each type of product. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for lavatories.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- C. Sustainable Design Submittals:
 - 1. Product Data: For water consumption.

1.4 CLOSEOUT SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Operation and Maintenance Data: For lavatories and faucets to include in operation and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. 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 10 percent of amount of each type and size installed.

PART 2 - PRODUCTS

2.1 LAVATORIES

A. Lavatories, L-1:

- 1. Description: Accessible, counter-mounting solid-surface fixture integral with solid-surface countertop. Solid-surface countertop and lavatories are specified in Division 06 "Interior Architectural Woodwork."
 - a. Oval Lavatory Size: 20 by 17 inches.
 - b. Faucet Hole Punching: One hole.
 - c. Faucet Hole Location: Top.
 - d. Faucet: Lavatory L-1/2.
 - e. Supplies: NPS 3/8 chrome-plated copper with stops.
 - f. Drain: See faucet.
 - 1) Location: Near back of bowl.
 - g. Protective Shielding Guard(s): Not required.

B. Lavatories, L-2:

- 1. Basis-of-Design Product: Subject to compliance with requirements, provide Kohler Model Kingston K-2005 or a comparable product by one of the following:
 - a. American Standard.
 - b. Crane Plumbing, L.L.C./Fiat Products.
 - c. Eljer.
 - d. TOTO USA, Inc.
 - e. Zurn.
- 2. Description: Accessible, wall mounting, vitreous-china fixture.
 - a. Type: Self draining deck with integral back and side shields.
 - b. Size: 20 by 18 inches rectangular.
 - c. Faucet Hole Punching: One hole.
 - d. Faucet Hole Location: Top.

- e. Color: White.
- f. Faucet: Lavatory L-1/2.
- g. Supplies: NPS 3/8 chrome-plated copper with stops.
- h. Drain: See faucet.

1) Location: Near back of bowl.

- i. Protective Shielding Guard(s): L-2.
- j. Fixture Support: Type II, concealed-arm lavatory carrier. Include rectangular steel uprights with integral welded feet.

2.2 SOLID-BRASS, MANUALLY OPERATED FAUCETS

- A. NSF Standard: Comply with NSF/ANSI 61 Annex G, "Drinking Water System Components - Health Effects," for faucet materials that will be in contact with potable water.
- B. Lavatory Faucets L-1/2: Manual-type, solid-brass valve.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Moen Model 8413F03 or a comparable approved product.
 - 2. Standard: ASME A112.18.1/CSA B125.1.
 - 3. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and fixture receptor.
 - 4. Body Material: Commercial, solid brass.
 - 5. Finish: Polished chrome plate.
 - 6. Maximum Flow Rate: 0.35 gpm.
 - 7. Centers: 4-inch.
 - 8. Mounting Type: Deck, exposed.
 - 9. Valve Handle: Single lever.
 - 10. Inlets: NPS 3/8 tubing, plain end.
 - 11. Spout: Rigid type.
 - 12. Spout Outlet: Aerator.
 - 13. Drain: Grid strainer.

2.3 SUPPLY FITTINGS

- A. NSF Standard: Comply with NSF/ANSI 61 Annex G, "Drinking Water System Components - Health Effects," 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.

2.4 WASTE FITTINGS

- A. Standard: ASME A112.18.2/CSA B125.2.
- B. Drain: Grid type with NPS 1-1/4 offset and straight tailpiece.
- C. Trap:
 - 1. Size: NPS 1-1/2 by NPS 1-1/4.
 - 2. Material: Chrome-plated, two-piece, cast-brass trap and ground-joint swivel elbow with 0.032-inch- thick brass tube to wall; and chrome-plated, brass or steel wall flange.
 - 3. Material: Stainless-steel, two-piece trap and swivel elbow with 0.012-inch- thick stainless-steel tube to wall; and stainless-steel wall flange.

2.5 PROTECTIVE SHIELDING GUARDS

- A. Protective Shielding Pipe and Trap Protectors, L-2:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. McGuire Manufacturing Co., Inc.
 - b. Plumberex Specialty Products Inc.
 - c. TCI Products.
 - d. TRUEBRO, Inc.
 - 2. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.
- B. Protective Shielding Pipe and Trap Protectors, L-1, S-1L, S-1R, and S-2:
 - 1. Architectural skirt board trim. Refer to casework and countertop details on drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before lavatory installation.
- B. Examine counters and walls for suitable conditions where lavatories will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install lavatories level and plumb according to roughing-in drawings.
- B. Install supports, affixed to building substrate, for wall-mounted lavatories.
- C. Install accessible wall-mounted lavatories at handicapped/elderly mounting height for people with disabilities or the elderly, according to ICC/ANSI A117.1.
- D. 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 220518 "Escutcheons for Plumbing Piping."
- E. 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 Section 079200 "Joint Sealants."
- F. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories.

3.3 CONNECTIONS

- A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

3.4 ADJUSTING

- A. Operate and adjust lavatories and controls. Replace damaged and malfunctioning lavatories, fittings, and controls.
- B. Adjust water pressure at faucets to produce proper flow.

3.5 CLEANING AND PROTECTION

- A. After completing installation of lavatories, inspect and repair damaged finishes.
- B. Clean lavatories, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.
- C. Provide protective covering for installed lavatories and fittings.
- D. Do not allow use of lavatories for temporary facilities unless approved in writing by Owner.

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END OF SECTION

SECTION 224216.16 - COMMERCIAL SINKS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Service basins.
2. Utility sinks.
3. Sinks
4. Sink faucets.
5. Supply fittings.
6. Waste fittings.

- B. Sustainable Design Requirements: Work included in this specification shall conform to the US Green Building Council LEED requirements listed in Section 018113.23 "Sustainable Design Requirements - LEED 2009 for Schools."

1.3 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.

- B. Product Data: For each type of product. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for sinks.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

- C. Sustainable Design Submittals:

1. Product Data: For water consumption.

1.4 INFORMATIONAL SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.

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- B. Coordination Drawings: Counter cutout templates for mounting of counter-mounted lavatories, and rough-in and installation details for sinks, basins, and faucets.

1.5 CLOSEOUT SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Maintenance Data: For sinks to include in maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. 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 10 percent of amount of each type and size installed.
 - 3. Plaster Trap Replacement Bottles: 6 for each Art Room.

PART 2 - PRODUCTS

2.1 SERVICE BASINS

- A. Service Basins (MR-1): Terrazzo, floor mounted.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Florestone Model 92, or a comparable product by one of the following:
 - a. Crane Plumbing, L.L.C./Fiat Products.
 - b. Stern Williams Co.
 - 2. Fixture:
 - a. Standard: IAPMO PS 99.
 - b. Shape: Square.
 - c. Nominal Size: 36 by 36 inches.
 - d. Height: 12 inches with dropped front.
 - e. Tiling Flange: As required to suit installation location, refer to drawings.
 - f. Rim Guard: On all top surfaces.
 - g. Color: Not applicable.
 - h. Drain: Grid with NPS 3 outlet.

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3. Mounting: On floor and flush to wall.
4. Faucet: MR-1.

2.2 UTILITY SINKS

A. Utility Sinks (S-3): Stainless steel, freestanding, one compartment with integral backsplash.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Elkay Manufacturing Co. Model SSP 1C-24x24-0, or a comparable product by one of the following:
 - a. Advance Tabco.
 - b. Eagle Group; Foodservice Equipment Division.
 - c. Griffin Products Inc.
2. Fixture:
 - a. Standard: ASME A112.19.3/CSA B45.4.
 - b. Type: With backsplash.
 - c. Number of Compartments: One.
 - d. Overall Dimensions: 29 inches long by 29-3/4 inches wide.
 - e. Metal Thickness: 16 gage.
 - f. Compartment:
 - 1) Drain: Grid with NPS 2 tailpiece and twist lever drain.
 - 2) Drain Location: Near back of compartment.
 - 3) Dimensions: 24 inches long by 24 inches wide by 12 inches deep.
3. Supports: Adjustable-length steel legs.
4. Faucet(s) S-3:
 - a. Number Required: One.
 - b. Mounting: On backsplash.
5. Supply Fittings:
 - a. Standard: ASME A112.18.1/CSA B125.1.
 - b. Supplies: Chrome-plated brass compression stop with inlet connection matching water-supply piping type and size.
 - 1) Operation: Loose keys.
6. Waste Fittings:
 - a. Standard: ASME A112.18.2/CSA B125.2.
 - b. Trap(s):
 - 1) Size: NPS 2.

- 2) Material: Chrome-plated, two-piece, cast-brass trap and ground-joint swivel elbow with 0.032-inch-thick brass tube to wall; and chrome-plated brass or steel wall flange.

2.3 SINKS

A. Stainless Steel Classroom Sinks (S-1L and S-1R):

1. Basis-of-Design Product: Subject to compliance with requirements, provide Elkay Model DRKAD-2220 sink or a comparable product by one of the following:
 - a. Dayton Products, Inc.
 - b. Just Manufacturing Co.
 - c. Franke Consumer Products, Inc., Kitchen Systems Div.
2. Description: One-bowl, ADA compliant, counter-mounting, Type 304 stainless-steel kitchen sink, single faucet hole, single bubbler hole. For S-1R, bubbler hole shall be in front right-hand side; for S-1L bubbler hole shall be in front left-hand side.
 - a. Overall Dimensions: 22 inches long by 20 inches wide, with 6-1/2-inch deep bowl with rear faucet ledge and right or left side bubbler ledge.
 - b. Metal Thickness: 18 gauge.
 - c. Bowl:
 - 1) Dimensions: 16 inches long by 13-1/2 inches wide by 6-1/2 inches deep.
 - 2) Drain: 3-1/2-inch crumb cup or basket strainer.
 - a) Location: Off-centered, near back of bowl.
 - d. Sink Faucet: S-1 faucet and bubbler.
 - e. Supplies: NPS 1/2 chrome-plated copper with stops.
 - f. Drain Piping: NPS 1-1/2 chrome-plated, cast-brass P-Trap; 0.045-inch-thick tubular brass waste to wall; and wall escutcheon.
 - g. Protective Shielding Guards: Not required.

B. Stainless Steel General Purpose Sinks (S-2):

1. Basis-of-Design Product: Subject to compliance with requirements, provide Elkay Model LRAD 2219 sink, or a comparable product by one of the following:
 - a. Dayton Products, Inc.
 - b. Just Manufacturing Co.
 - c. Franke Consumer Products, Inc., Kitchen Systems Div.
2. Description: One-bowl, ADA compliant, residential, counter-mounting, Type 304 stainless-steel kitchen sink, one center faucet hole.
 - a. Overall Dimensions: 22 inches long by 19 inches wide, with 6-1/2-inch deep bowl with rear faucet ledge.

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- b. Metal Thickness: 18 gauge.
- c. Bowl:
 - 1) Dimensions: 18 inches long by 14 inches wide by 6-1/2 inches deep.
 - 2) Drain: 3-1/2-inch grid crumb cup or basket strainer.
 - a) Location: Near back of bowl.
- d. Sink Faucet: S-2.
- e. Supplies: NPS 1/2 chrome-plated copper with stops.
- f. Drain Piping: NPS 1-1/2 chrome-plated, cast-brass P-trap; 0.045-inch- thick tubular brass waste to wall; and wall escutcheon.
- g. Protective Shielding Guards: Not required.

C. Stainless Steel, Deep Bowl, Art Sink (S-4):

- 1. Basis-of-Design Product: Subject to compliance with requirements, provide Elkay model DLR-2222-10 or a comparable product by one of the following:
 - a. Dayton Products, Inc.
 - b. Just Manufacturing Co.
 - c. Franke Consumer Products, Inc., Kitchen Systems Div.
- 2. Description: One-bowl, counter-mounting, Type 304 stainless-steel kitchen sink, one center faucet hole.
 - a. Overall Dimensions: 22 inches long by 22 inches wide, with 10-inch deep bowl.
 - b. Metal Thickness: 18 gauge.
 - c. Bowl:
 - 1) Dimensions: 19 inches long by 16 inches wide by 12-inches deep.
 - 2) Drain: Single drain, located in center of bowl, grid strainer with twist lever drain.
 - d. Sink Faucet: S-4.
 - e. Supplies: NPS 1/2 chrome-plated copper with stops.
 - f. Drain Piping: NPS 1-1/2 PVC; plaster trap S-4; and wall escutcheon.

D. Stainless Steel, Wall Hung, Art Sink (S-5):

- 1. Basis-of-Design Product: Subject to compliance with requirements, provide Elkay model EWMA 4820 or a comparable product by one of the following:
 - a. Advance Tabco.
 - b. Just Manufacturing Company.
 - c. Metal Masters Foodservice Equipment Co., Inc.
- 2. Description: Wall-mounting, type 304 stainless-steel, commercial, general purpose-sink fixture.

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- a. Type: Two station basin with 1/4-inch radius corners, high backsplash for faucet, inward sloping top channel rims, and support brackets.
- b. Size: Approximately 48-inches long by 20-inches deep
- c. Faucets: One each S-5A and S-5B for each sink. Coordinate required faucet drilling with manufacturer. Locate S-5A faucet on left position and faucet S-5B on right position.
- d. Supplies: NPS 1/2 chrome-plated copper with stops.
- e. Drain: Single drain, located in center of basin, grid strainer with twist lever drain.
- f. Drain Piping: NPS 1-1/2 PVC; plaster trap S-5; and wall escutcheon.
- g. Fixture Support: By manufacturer.

2.4 SINK FAUCETS

A. General Purpose Classroom Sink Faucets and Bubblers (S-1L and S-1R):

1. Basis-of-Design Product: Subject to compliance with requirements, provide Zurn Model Z82300-XL faucet and Zurn Model Z83600-XL bubbler or a comparable product by one of the following:
 - a. American Standard Companies, Inc.
 - b. Bradley Corporation.
 - c. Chicago Faucets.
 - d. Elkay Manufacturing Co.
 - e. Fisher Manufacturing Co.
 - f. Grohe America, Inc.
 - g. Just Manufacturing Company.
 - h. Kohler Co.
 - i. T&S Brass and Bronze Works, Inc.
2. Description: Kitchen faucet less spray, for single-hole fixture and separate bubbler. Include hot- and cold-water indicators; coordinate faucet and bubbler inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor. ADA compliant.
 - a. Body Material: Commercial, solid brass.
 - b. Finish: Polished chrome plate.
 - c. Maximum Flow Rate: 1.5 gpm with aerator.
 - d. Mixing Valve: Single control.
 - e. Centers: Single hole.
 - f. Mounting: Deck.
 - g. Handle(s): Lever.
 - h. Inlet(s): NPS 3/8 plain-end tubing.
 - i. Spout Type: Swing, shaped tube.
 - j. Spout Outlet: Aerator, 1.5 gpm.
 - k. Vacuum Breaker: Not required.
 - l. Operation: Noncompression, manual.
 - m. Drain: 3-1/2 inch outlet with removable crumb cup or basket strainer. Provide tailpiece with dishwasher connection where indicated on Drawings.
 - n. Bubbler: Anti-microbial flex head; push button operation; chrome plate finish; 0.7 gpm flow rate.

B. General Purpose Sink Faucets (S-2):

1. Basis-of-Design Product: Subject to compliance with requirements, provide Zurn Model Z82300-XL faucet:
 - a. American Standard Companies, Inc.
 - b. Bradley Corporation.
 - c. Chicago Faucets.
 - d. Elkay Manufacturing Co.
 - e. Fisher Manufacturing Co.
 - f. Grohe America, Inc.
 - g. Just Manufacturing Company.
 - h. Kohler Co.
 - i. T&S Brass and Bronze Works, Inc.
2. Description: Kitchen faucet less spray for single-hole fixture. Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor. ADA compliant.
 - a. Body Material: Commercial, solid brass.
 - b. Finish: Polished chrome plate.
 - c. Maximum Flow Rate: 1.5 gpm with aerator.
 - d. Mixing Valve: Single control.
 - e. Centers: Single hole.
 - f. Mounting: Deck.
 - g. Handle(s): Lever.
 - h. Inlet(s): NPS 3/8 plain-end tubing.
 - i. Spout Type: Swing, shaped tube.
 - j. Spout Outlet: Aerator, 1.5 gpm.
 - k. Vacuum Breaker: Not required.
 - l. Operation: Noncompression, manual.
 - m. Drain: 3-1/2 inch outlet with removable crumb cup or basket strainer.

C. Sink Faucets, S-3:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Zurn Model Z842H1-XL or a comparable product.
2. Description: Service sink faucet with stops in shanks. Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.
 - a. Body Material: Commercial, solid brass.
 - b. Finish: Polished chrome plate.
 - c. Maximum Flow Rate: 1.5 gpm.
 - d. Mixing Valve: Two-lever handle.
 - e. Mounting: Back/wall.
 - f. Handle(s): Lever.
 - g. Inlet(s): 1/2" NPT female threaded.
 - h. Spout Type: Swing, round tubular, 12 inches long.
 - i. Spout Outlet: 1.5 gpm vandal-resistant, pressure compensating, female aerator.

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- j. Operation: Noncompression, manual.
- k. Drain: Grid with waste pipe twist handle drain. Single drain for two faucets.

D. Art Room Sink Faucet (S-4):

1. Basis-of-Design Product: Subject to compliance with requirements, provide Zurn Model Z82300-XL faucet:
 - a. American Standard Companies, Inc.
 - b. Bradley Corporation.
 - c. Elkay Manufacturing Co.
 - d. Fisher Manufacturing Co.
 - e. Grohe America, Inc.
 - f. Just Manufacturing Company.
 - g. Kohler Co.
 - h. T&S Brass and Bronze Works, Inc.
2. Description: Kitchen faucet less spray for single-hole fixture. Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor. ADA compliant.
 - a. Body Material: Commercial, solid brass.
 - b. Finish: Polished chrome plate.
 - c. Maximum Flow Rate: 1.5 gpm with aerator.
 - d. Mixing Valve: Single control.
 - e. Centers: Single hole.
 - f. Mounting: Deck.
 - g. Handle(s): Lever.
 - h. Inlet(s): NPS 3/8 plain-end tubing.
 - i. Spout Type: Swing, shaped tube.
 - j. Spout Outlet: Aerator, 1.5 gpm.
 - k. Vacuum Breaker: Not required.
 - l. Operation: Noncompression, manual.
 - m. Drain: Grid with waste pipe lever handle drain.

E. Sink Faucets (S-5A):

1. Basis-of-Design Product: Subject to compliance with requirements, provide Zurn Model Z842F1-XL or a comparable product.
2. Description: Service sink faucet with stops in shanks. Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.
 - a. Body Material: Commercial, solid brass.
 - b. Finish: Polished chrome plate.
 - c. Maximum Flow Rate: 1.5 gpm.
 - d. Mixing Valve: Two-lever handle.
 - e. Mounting: Back/wall.
 - f. Handle(s): Lever.
 - g. Inlet(s): 1/2-inch NPT female threaded.

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- h. Spout Type: Swing, round tubular, 6 inches long.
- i. Spout Outlet: 1.5 gpm vandal-resistant, pressure compensating, female aerator.
- j. Operation: Noncompression, manual.
- k. Drain: Grid with waste pipe twist handle drain. Single drain for two faucets.

F. Sink Faucets (S-5B):

1. Basis-of-Design Product: Subject to compliance with requirements, provide Zurn Model Z842F1-AF-PR2 or a comparable product.
2. Description: Service sink faucet with stops in shanks, two-lever-handle mixing valve with diverter valve and pre-rinse hose and spray valve. Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.
 - a. Body Type: Widespread
 - b. Body Material: Commercial, solid brass.
 - c. Finish: Polished chrome plate.
 - d. Maximum Flow Rate: 1.5 gpm, at both faucet and spray valve.
 - e. Mixing Valve: Two-lever handle.
 - f. Mounting: Back/wall, exposed.
 - g. Handle(s): Lever.
 - h. Inlet(s): 1/2-inch NPT female threaded.
 - i. Spout Type: Swing, round tubular, 6 inches long.
 - j. Spout Outlet: 1.5 gpm vandal-resistant, pressure compensating, female aerator.
 - k. Operation: Noncompression, manual.
 - l. Drain: With faucet S-5A.
 - m. Pre-Rinse Spray Valve: Hose mounted, spring action, squeeze lever operation, 1.5 gpm maximum.
 - n. Pre-Rinse Rinse Hose: Rubber with protective spring coil, with wall mounting bracket and finger hook.

G. Service Sink Faucets (MR-1):

1. Basis-of-Design Product: Subject to compliance with requirements, provide Zurn Model Z843M1 or a comparable product by one of the following:
 - a. American Standard Companies, Inc.
 - b. Bradley Corporation.
 - c. Chicago Faucets.
 - d. Elkay Manufacturing Co.
 - e. Fisher Manufacturing Co.
 - f. Grohe America, Inc.
 - g. Just Manufacturing Company.
 - h. Kohler Co.
 - i. T & S Brass and Bronze Works, Inc.
2. Description: Service sink faucet with stops in shanks, vacuum breaker, hose-thread outlet, and pail hook. Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.

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- a. Body Material: Commercial, solid brass
- b. Finish: Chrome plate rough brass
- c. Maximum Flow Rate: 2.5 gpm
- d. Mixing Valve: Two-lever handle.
- e. Centers: 8 inches, adjustable.
- f. Mounting: Back/wall.
- g. Handle(s): Lever
- h. Inlet(s): 1/2 female threaded.
- i. Spout Type: Rigid, solid brass with wall brace
- j. Spout Outlet: Hose thread.
- k. Vacuum Breaker: Required.
- l. Operation: Noncompression, manual.
- m. Drain: Grid.

2.5 SUPPLY FITTINGS

- A. NSF Standard: Comply with NSF/ANSI 61 Annex G, "Drinking Water System Components - Health Effects," 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.

2.6 WASTE FITTINGS

- A. Standard: ASME A112.18.2/CSA B125.2.
- B. Drain: Grid type with NPS 1-1/2 or NPS 2 offset and straight tailpiece or twist lever drain where indicated.
- C. Trap:
 - 1. Size: NPS 1-1/2 or NPS 2.
 - 2. Material: Chrome-plated, two-piece, cast-brass trap and ground-joint swivel elbow with 0.032-inch- thick brass tube to wall; and chrome-plated brass or steel wall flange.
- D. Plaster Traps, S-4 and S-5:
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Gleco Trap model GT64 or a comparable product.

2. Description: Manufactured assembly included screw top, 84 ounce capacity translucent plastic bottle with O-ring seal; PVC piping components; and integral PVC drain line and valve.

2.7 GROUT

- A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before sink installation.
- B. Examine walls, floors, and counters for suitable conditions where sinks will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturer's written instructions.
- B. Install sinks level and plumb according to roughing-in drawings.
- C. Install supports, affixed to building substrate, for wall-hung sinks.
- D. Install counter-mounting fixtures in and attached to casework.
- E. Install accessible wall-mounted sinks at handicapped/elderly mounting height according to ICC/ANSI A117.1.
- F. Set floor-mounted sinks in leveling bed of cement grout.
- G. Install water-supply piping with stop on each supply to each sink faucet.
 1. Exception: Use ball or gate valves if supply stops are not specified with sink. Comply with valve requirements specified in Section 220523.12 "Ball Valves for Plumbing Piping."

2. Install stops in locations where they can be easily reached for operation.
- H. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.
- I. 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 220518 "Escutcheons for Plumbing Piping."
- J. 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 Section 079200 "Joint Sealants."
- K. Set mop receptor in leveling bed of cement grout. Grout is specified in Section 033000 "Cast-In-Place Concrete."

3.3 CONNECTIONS

- A. Connect sinks with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

3.4 FIELD QUALITY CONTROL

- A. Verify that installed plumbing fixtures are categories and types specified for locations where installed.
- B. Check that plumbing fixtures are complete with trim, faucets, fittings, and other specified components.
- C. Inspect installed plumbing fixtures for damage. Replace damaged fixtures and components.
- D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

3.5 ADJUSTING

- A. Operate and adjust sinks and controls. Replace damaged and malfunctioning sinks, fittings, and controls.
- B. Adjust water pressure at faucets to produce proper flow.

3.6 CLEANING AND PROTECTION

- A. After completing installation of sinks, inspect and repair damaged finishes.
- B. Clean sinks, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.
- C. Provide protective covering for installed sinks and fittings.
- D. Do not allow use of sinks for temporary facilities unless approved in writing by Owner.

END OF SECTION

SECTION 224223 - COMMERCIAL SHOWERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

- 1. Individual shower receptors.
- 2. Shower faucets.
- 3. Grout.

B. Related Requirements:

- 1. Section 221319.13 "Sanitary Drains" for shower drains.

1.3 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of the Construction Contract Clauses, Section 007213 "General Conditions" and the individual sections specifying the work.

- B. Product Data: For each type of product. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.

- 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for showers.
- 2. Include rated capacities, operating characteristics, and furnished specialties and accessories.

1.4 CLOSEOUT SUBMITTALS

- A. Submittals shall comply with the requirements of the Construction Contract Clauses, Section 007213 "General Conditions" and the individual sections specifying the work.

- B. Maintenance Data: For shower faucets to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 INDIVIDUAL SHOWERS

A. Individual FRP Showers, Accessible for Side Transfer (SH-1):

1. **Basis-of-Design Product:** Subject to compliance with requirements, provide Oasis Model SHFW-WX-3837 / ANS09-RS, or a comparable approved product.
2. General: FRP, accessible, shower enclosure with faucet and receptor and appurtenances.
3. Standard: ANSI Z124.1.2.
4. Type: One-piece unit without top.
5. Style: Handicapped/wheelchair.
6. Faucet: SH-1.
7. Nominal Size and Shape: 36 by 36 inches square.
8. Color: White.
9. Bathing Surface: Slip resistant according to ASTM F 462.
10. Outlet: Drain with NPS 2 outlet.
11. Shower Rod: Required.
12. Grab Bar: ANSI A117.1, horizontal and vertical bars.
13. Folding Seat: Factory mounted.

B. Individual FRP Showers, Standard (SH-2):

1. **Basis-of-Design Product:** Subject to compliance with requirements, provide Oasis Legacy Model SH-3, or a comparable approved product.
2. General: FRP, shower enclosure and receptor.
3. Standard: ANSI Z124.1.2.
4. Type: One-piece unit without top.
5. Style: Standard.
6. Faucet: SH-2.
7. Nominal Size and Shape: 36 by 36 inches square.
8. Color: White.
9. Bathing Surface: Slip resistant according to ASTM F 462.
10. Outlet: Drain with NPS 2 outlet.
11. Integral Shelves: Required.

2.2 SHOWER FAUCETS

A. NSF Standard: Comply with NSF 61 Annex G, "Drinking Water System Components - Health Effects," for shower materials that will be in contact with potable water.

B. Shower Faucets, Accessible (SH-1):

1. **Basis-of-Design Product:** Subject to compliance with requirements, provide Zurn Industries Temp-Gard III Model Z7300-SS-HX-MT or a comparable product by one of the following:
 - a. Kohler Co.

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- b. Leonard Valve Company.
 - c. Moen Incorporated.
 - d. Sloan Valve Company.
2. Description: Single-handle, pressure-balance mixing valve with hot- and cold-water indicators; check stops; and removable hand shower with hose and slide bar.
3. Faucet:
 - a. Standards: ASME A112.18.1/CSA B125.1 and ASSE 1016.
 - b. Body Material: Solid brass.
 - c. Finish: Polished chrome plate.
 - d. EPA WaterSense: Required.
 - e. Mounting: Concealed.
 - f. Operation: Single-handle, twist or rotate control.
 - g. Antiscald Device: Integral with mixing valve.
 - h. Check Stops: Check-valve type, integral with or attached to body; on hot- and cold-water supply connections.
4. Supply Connections: NPS 1/2.
5. Shower Head:
 - a. Standard: ASME A112.18.1/CSA B125.1.
 - b. Type: Fixed flow, hand held.
 - c. Spray Pattern: Fixed.
 - d. Integral Volume Control: 1.5 gpm flow restrictor.
 - e. Hose: 59-inch length.
 - f. Slide Bar: 25-inch, metal.
 - g. Vacuum Breaker: Required.

C. Shower Faucets, Standard (SH-2):

1. Basis-of-Design Product: Subject to compliance with requirements, provide Zurn Industries Temp Gard III Model Z7301-SS-MT or a comparable product by one of the following:
 - a. Kohler Co.
 - b. Leonard Valve Company.
 - c. Moen Incorporated.
 - d. Sloan Valve Company.
2. Description: Single-handle, pressure-balance mixing valve with hot- and cold-water indicators; check stops; and adjustable position shower head.
3. Faucet:
 - a. Standards: ASME A112.18.1/CSA B125.1 and ASSE 1016.
 - b. Body Material: Solid brass.
 - c. Finish: Polished chrome plate.
 - d. Shower-Arm, Flow-Control Fitting: 1.5 gpm.
 - e. EPA WaterSense: Required.
 - f. Mounting: Concealed.

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- g. Operation: Single-handle, twist or rotate control.
 - h. Antiscald Device: Integral with mixing valve.
 - i. Check Stops: Check-valve type, integral with or attached to body; on hot- and cold-water supply connections.
- 4. Supply Connections: NPS 1/2.
 - 5. Shower Head:
 - a. Standard: ASME A112.18.1/CSA B125.1.
 - b. Type: Ball joint with arm and flange.
 - c. Shower Head Material: Metallic with chrome-plated finish.

2.3 GROUT

- A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of water-supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before shower installation.
- B. Examine walls and floors for suitable conditions where showers will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Assemble shower components according to manufacturers' written instructions.
- B. Install showers level and plumb according to roughing-in drawings.
- C. Install water-supply piping with stop on each supply to each shower faucet.
 - 1. Exception: Use ball valves if supply stops are not specified with shower. Comply with valve requirements specified in Section 220523.12 "Ball Valves for Plumbing Piping."
 - 2. Install stops in locations where they can be easily reached for operation.
- D. Install shower flow-control fittings with specified maximum flow rates in shower arms.

- E. Set shower receptors in leveling bed of cement grout.
- F. 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 escutcheons requirements specified in Section 220518 "Escutcheons for Plumbing Piping."
- G. Seal joints between showers and floors and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

3.3 CONNECTIONS

- A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."
- C. Comply with traps and soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

3.4 ADJUSTING

- A. Operate and adjust showers and controls. Replace damaged and malfunctioning showers, fittings, and controls.
- B. Adjust water pressure at faucets to produce proper flow.

3.5 CLEANING AND PROTECTION

- A. After completing installation of showers, inspect and repair damaged finishes.
- B. Clean showers, 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 showers for temporary facilities unless approved in writing by Owner.

END OF SECTION

SECTION 224233 - WASH FOUNTAINS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Linear wash fountains.
- B. Related Requirements:
 - 1. Section 224216.13 "Commercial Lavatories."
 - 2. Section 224216.16 "Commercial Sinks."

1.3 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Product Data: For each type of product. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for wash fountains.
 - 2. Include rated capacities, operating characteristics, and furnished specialties and accessories.
- C. Sustainable Design Submittals:
 - 1. Product Data: For water consumption.
- D. Shop Drawings: For each type of wash fountain.
 - 1. Include plans, elevations, sections, and mounting attachment details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

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1.4 CLOSEOUT SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 “Submittal Procedures” and the individual sections specifying the work.
- B. Operation and Maintenance Data: For wash fountains and components to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 SOLID-SURFACE, LINEAR WASH FOUNTAINS

- A. Wash Fountains (WF-1): Solid-surface, linear (side-by-side) receptor.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Sloan Stone Model ELS-73250 or comparable product by one of the following:
 - a. Acorn Engineering Company.
 - b. Intersan Manufacturing Company.
 - 2. Standard: IAPMO IGC 156.
 - 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. Standard: ICPA SS-1 for solid-surface bowls.
 - b. Height to Rim: 34 inches above floor.
 - c. Color or Finish: Manufacturer's standard color as selected by Architect.
 - d. Number of Stations: Three.
 - e. Drain: Grid with NPS 1-1/2 tailpiece, two total.
 - 5. Apron: Required, with access panel.
 - 6. Faucets:
 - a. Standards: ASME A112.18.1/CSA B125.1 and NSF 61 Annex G.
 - b. Type: Manufacturer's standard, pedestal type, chrome-plated solid brass, each user station.
 - c. Control: Battery-powered, sensor-actuated mixing valve with check stops for each user station.
 - d. Sensor: ASME A112.18.1/CSA B125.1 and UL 1951.
 - 7. Liquid-Soap Dispensers: Not required.
 - 8. Mounting: Off floor on wall brackets.
 - 9. Supply Fittings:
 - a. Piping: NPS 1/2 copper tubing, each station.
 - b. Valves: Shutoff valve on each supply.

- c. Supply Piping: From wall.
10. Waste Fittings:
- a. Standard: ASME A112.18.2/CSA B125.2.
 - b. Trap and Drain Piping: NPS 1-1/2, each drain.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of water-supply, sanitary drainage, and vent piping systems to verify actual locations of piping connections before wash-fountain installation.
- B. Examine walls and floors for suitable conditions where wash fountains will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install wash fountains level and plumb according to roughing-in drawings.
- B. Install off-floor carrier supports, affixed to building substrate, for wall-mounted wash fountains.
- C. Install accessible, wall-mounted wash fountains at mounting height for handicapped/elderly according to ICC A117.1.
- D. Install water-supply piping with shutoff valve on each supply to each wash fountain to be connected to domestic-water distribution piping. Use ball valve. Install valves in locations where they can be easily reached for operation. Valves are specified in Section 220523.12 "Ball Valves for Plumbing Piping."
- E. Install trap and waste piping on each drain outlet of each wash fountain to be connected to sanitary drainage system.
- F. 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 220518 "Escutcheons for Plumbing Piping."
- G. Seal joints between fixtures and walls using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

3.3 CONNECTIONS

- A. Connect wash fountains with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

- B. Comply with requirements for water piping specified in Section 221116 "Domestic Water Piping."
- C. Comply with requirements for soil and waste drainage piping and vent piping specified in Section 221316 "Sanitary Waste and Vent Piping."

3.4 ADJUSTING

- A. Operate and adjust wash fountains and controls. Replace damaged and malfunctioning wash fountains, fittings, and controls.
- B. Adjust water pressure at faucets to produce proper flow.
- C. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

3.5 CLEANING AND PROTECTION

- A. After installing wash fountains, inspect and repair damaged finishes.
- B. Clean wash fountains, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.
- C. Provide protective covering for installed wash fountains and fittings.
- D. Do not allow use of wash fountains for temporary facilities unless approved in writing by Owner.

END OF SECTION

SECTION 224500 - EMERGENCY PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Eyewash equipment.
 - 2. Eye/face wash equipment.
 - 3. Combination units.
 - 4. Water-tempering equipment.

1.3 DEFINITIONS

- A. Accessible Fixture: Emergency plumbing fixture that can be approached, entered, and used by people with disabilities.
- B. Plumbed Emergency Plumbing Fixture: Fixture with fixed, potable-water supply.
- C. Tepid: Moderately warm.

1.4 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Product Data: For each type of product indicated. Include flow rates and capacities, furnished specialties, and accessories. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.

1.5 INFORMATIONAL SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Product Certificates: Submit certificates of performance testing specified in "Source Quality Control" Article.

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- C. Field quality-control test reports.

1.6 CLOSEOUT SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Operation and Maintenance Data: For emergency plumbing fixtures to include in operation and maintenance manuals.

1.7 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. ANSI Standard: Comply with ANSI Z358.1, "Emergency Eyewash and Shower Equipment."
- C. NSF Standard: Comply with NSF 61 Annex G, "Drinking Water System Components - Health Effects," for fixture materials that will be in contact with potable water.
- D. Regulatory Requirements: Comply with requirements in ICC/ANSI A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for plumbing fixtures for people with disabilities.

PART 2 - PRODUCTS

2.1 EYEWASH EQUIPMENT

- A. Sink, Swivel-Type, Plumbed Eyewash Unit (EM-2)
 - 1. **Basis-of-Design Product:** Subject to compliance with requirements, provide Guardian Model G1849LH-L or comparable product by one of the following:
 - a. **Bradley Corporation.**
 - b. Encon Safety Products.
 - c. Haws Corporation.
 - 2. Capacity: Not less than 0.4 gpm for at least 15 minutes.
 - 3. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
 - 4. Control-Valve Actuator: Movement of spray-head assembly to position over sink.
 - 5. Spray-Head Assembly: Two spray heads with offset piping.
 - 6. Mounting: Next to faucet on rear deck.

2.2 EYE/FACE WASH EQUIPMENT

A. Standard, Wall-Mounted, Plumbed, Eye/Face Wash Units (EM-3):

1. **Basis-of-Design Product:** Subject to compliance with requirements, provide Guardian Model G1750, or a comparable product by one of the following:
 - a. Bradley Corporation.
 - b. Encon Safety Products.
 - c. Haws Corporation.
 - d. WaterSaver Faucet Co.
2. Capacity: Not less than 3.0 gpm for at least 15 minutes.
3. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
4. Control-Valve Actuator: Paddle.
5. Spray-Head Assembly: Two or four receptor-mounted spray heads.
6. Receptor: Chrome-plated brass or stainless-steel bowl.
7. Mounting: Wall bracket.
8. Special Construction: Comply with ICC/ANSI A117.1.
9. Drain Piping: NPS 1-1/4 minimum tailpiece for connection to indirect waste piping.

2.3 COMBINATION UNITS

A. Accessible, Plumbed Emergency Shower with Eye/Face Wash Combination Units (EM-1):

1. **Basis-of-Design Product:** Subject to compliance with requirements, provide Guardian Model GBF1909SSH, or a comparable product by one of the following:
 - a. Acorn Safety.
 - b. Bradley Corporation.
 - c. Encon Safety Products.
 - d. Haws Corporation.
 - e. WaterSaver Faucet Co.
2. Piping:
 - a. Material: Chrome-plated brass or stainless steel.
 - b. Unit Supply: NPS 1-1/4 minimum.
 - c. Unit Drain: Outlet at back or side near bottom.
3. Shower:
 - a. Capacity: Not less than 20 gpm for at least 15 minutes.
 - b. Supply Piping: NPS 1 with flow regulator and stay-open control valve.
 - c. Control-Valve Actuator: Pull rod.
 - d. Shower Head: 8-inch- minimum diameter, chrome-plated brass or stainless steel.
 - e. Mounting: Pedestal.

4. Eye/Face Wash Unit:
 - a. Capacity: Not less than 3 gpm for at least 15 minutes.
 - b. Supply Piping: NPS 1/2 with flow regulator and stay-open control valve.
 - c. Control-Valve Actuator: Paddle.
 - d. Spray-Head Assembly: Two or four receptor-mounted spray heads.
 - e. Receptor: Chrome-plated brass or stainless-steel bowl.
 - f. Mounting: Attached to shower pedestal.

2.4 WATER-TEMPERING EQUIPMENT

A. Hot- and Cold-Water, Water-Tempering Equipment (EMV):

1. Basis-of-Design Product: Subject to compliance with requirements, provide product scheduled on Drawings or a comparable product by one of the following:
 - a. Encon Safety Products.
 - b. Haws Corporation.
 - c. Leonard Valve Company.
 - d. Powers.
2. Description: Factory-fabricated equipment with thermostatic mixing valve.
 - a. Thermostatic Mixing Valve: Designed to provide 85 deg F tepid, potable water at emergency plumbing fixtures, to maintain temperature at plus or minus 5 deg F throughout required 15-minute test period, and in case of unit failure to continue cold-water flow, with union connections, controls, metal piping, and corrosion-resistant enclosure.
 - b. Supply Connections: For hot and cold water.

2.5 SOURCE QUALITY CONTROL

- A. Certify performance of emergency plumbing fixtures by independent testing organization acceptable to authorities having jurisdiction.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for water and waste piping systems to verify actual locations of piping connections before plumbed emergency plumbing fixture installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EMERGENCY PLUMBING FIXTURE INSTALLATION

- A. Assemble emergency plumbing fixture piping, fittings, control valves, and other components.
- B. Install fixtures level and plumb.
- C. Fasten fixtures to substrate.
- D. Install shutoff valves in water-supply piping to fixtures. Use ball valve if specific type valve is not indicated. Install valves chained or locked in open position if permitted. Install valves in locations where they can easily be reached for operation. Comply with requirements for valves specified in Section 220523.12 "Ball Valves for Plumbing Piping."
 - 1. Exception: Omit shutoff valve on supply to emergency equipment if prohibited by authorities having jurisdiction.
- E. Install dielectric fitting in supply piping to emergency equipment if piping and equipment connections are made of different metals. Comply with requirements for dielectric fittings specified in Section 221116 "Domestic Water Piping."
- F. Install thermometers in supply and outlet piping connections to water-tempering equipment. Comply with requirements for thermometers specified in Section 220519 "Meters and Gages for Plumbing Piping."
- G. Install indirect waste piping on drain outlet of emergency equipment receptors that are indicated to be directly connected to drainage system. Comply with requirements for waste piping specified in Section 221316 "Sanitary Waste and Vent Piping."
- H. Install escutcheons on piping wall and ceiling penetrations in exposed, finished locations. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.3 CONNECTIONS

- A. Connect hot- and cold-water-supply piping to hot- and cold-water, water-tempering equipment. Connect output from water-tempering equipment to emergency plumbing fixtures. Comply with requirements for hot- and cold-water piping specified in Section 221116 "Domestic Water Piping."
- B. Indirectly connect emergency plumbing fixture receptors without trapped drain outlet to sanitary waste system. Comply with requirements for indirect waste piping specified in Section 221316 "Sanitary Waste and Vent Piping."
- C. Where installing piping adjacent to emergency plumbing fixtures, allow space for service and maintenance of fixtures.

3.4 IDENTIFICATION

- A. Install equipment nameplates or equipment markers on emergency plumbing fixtures and equipment and equipment signs on water-tempering equipment. Comply with requirements for identification materials specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.5 FIELD QUALITY CONTROL

- A. Mechanical-Component Testing: After plumbing connections have been made, test for compliance with requirements. Verify ability to achieve indicated capacities.
- B. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection.
 - 2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Emergency plumbing fixtures and water-tempering equipment will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

3.6 ADJUSTING

- A. Adjust or replace fixture flow regulators for proper flow.
- B. Adjust equipment temperature settings.

END OF SECTION

SECTION 224716 - PRESSURE WATER COOLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes pressure water coolers, bottle fillers, and related components.
- B. Sustainable Design Requirements: Work included in this specification shall conform to the US Green Building Council LEED requirements listed in Section 018113.23 "Sustainable Design Requirements - LEED 2009 for Schools."

1.3 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Product Data: For each type of pressure water cooler. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- C. Sustainable Design Submittals:
 - 1. **Product Data:** For water consumption.
- D. Shop Drawings: Include diagrams for power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Maintenance Data: For pressure water coolers to include in maintenance manuals.

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1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Filter Cartridges: Equal to 10 percent of quantity installed for each type and size indicated, but no fewer than two of each.

1.6 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. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for fixtures for people with disabilities.
- C. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.
- D. ARI Standard: Comply with ARI 1010, "Self-Contained, Mechanically Refrigerated Drinking-Water Coolers," for water coolers and with ARI's "Directory of Certified Drinking Water Coolers" for type and style classifications.
- E. ASHRAE Standard: Comply with ASHRAE 34, "Designation and Safety Classification of Refrigerants," for water coolers. Provide HFC 134a (tetrafluoroethane) refrigerant, unless otherwise indicated.

PART 2 - PRODUCTS

2.1 PRESSURE WATER COOLERS

- A. Pressure Water Coolers with Bottle Filler (EWC-1): Wall mounted, dual height, wheelchair accessible with integral bottle filler.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Elkay Manufacturing Co. LZSTL8WSSP, or a comparable product by available manufacturers offering products that may be incorporated into the Work which include, but are not limited to, the following:
 - a. Halsey Taylor.
 - 2. Standards:

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- a. Comply with NSF 61 Annex G.
 - b. Comply with ASHRAE 34, "Designation and Safety Classification of Refrigerants," for water coolers. Provide HFC 134a (tetrafluoroethane) refrigerant unless otherwise indicated.
3. Cabinet: Bi-level with two attached cabinets, vinyl-covered steel with stainless-steel top.
 4. Bubbler: Adjustable stream regulator, one located on each deck.
 5. Control: Push bar on front and sides.
 6. Drain: Grid with NPS 1-1/4 tailpiece.
 7. Supply: NPS 3/8 with shutoff valve.
 8. Waste Fitting: ASME A112.18.2/CSA B125.2, NPS 1-1/4 brass P-trap.
 9. Filter: One or more water filters complying with NSF 42 and NSF 53 for cyst and lead reduction to below EPA standards, with capacity sized for unit peak flow rate.
 10. Cooling System: Electric, with hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.
 - 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.
 11. Bottle Filler: Mounted on water cooler section:
 - a. Cabinet: Stainless steel and plastic.
 - b. Water Dispenser: Anti-microbial plastic with 1.1 gpm fill rate and laminar flow.
 - c. Control: Touchless operation with 30-second shut-off timer.
 - d. Drain: To water cooler deck.
 - e. Visual User Interface Display: Shall include a filter monitoring indicator for filter replacement and a "Green Ticker" indicating the quantity of bottles kept from landfills by use of the bottle filler.
 12. Capacities and Characteristics:
 - a. Cooled Water: 8 gph.
 - b. Ambient-Air Temperature: 90 deg F.
 - c. Inlet-Water Temperature: 80 deg F.
 - d. Cooled-Water Temperature: 50 deg F.
 - e. Electrical Characteristics:
 - 1) Volts: 120-V ac.
 - 2) Phase: Single.
 - 3) Hertz: 60.
 - 4) Full-Load Amperes: 4.0.
 13. Support: ASME A112.6.1M, Type I water-cooler carrier.

2.2 SUPPORTS

- A. Type I Water Cooler Carrier: Floor mounted plate type carrier with rectangular steel uprights with integral welded feet.
 - 1. Standard: ASME A112.6.1M.

PART 3 - EXECUTION

3.1 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.

3.2 INSTALLATION

- A. Install fixtures level and plumb according to roughing-in drawings. For fixtures indicated for children, install at height required by authorities having jurisdiction.
- B. Install off-the-floor carrier supports, affixed to building substrate, for wall-mounted fixtures.
- C. Install water-supply piping with shutoff valve on supply to each fixture to be connected to domestic-water distribution piping. Use ball valve. Install valves in locations where they can be easily reached for operation. Valves are specified in Section 220523.12 "Ball Valves for Plumbing Piping."
- D. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.
- E. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."
- F. Seal joints between fixtures and walls using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

3.3 CONNECTIONS

- A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."

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- C. Install ball shutoff valve on water supply to each fixture. Install valve upstream from filter for water cooler. Comply with valve requirements specified in Section 220523.12 "Ball Valves for Plumbing Piping."
- D. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

3.4 ADJUSTING

- A. Adjust fixture flow regulators for proper flow and stream height.
- B. Adjust pressure water-cooler temperature settings.

3.5 CLEANING

- A. After installing fixture, 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 230513 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

1.3 COORDINATION

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

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

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

2.2 MOTOR CHARACTERISTICS

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

2.3 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Premium efficiency.
- C. Service Factor: 1.15.
- D. Multispeed Motors: Variable torque.
 - 1. For motors with 2:1 speed ratio, consequent pole, single winding.
 - 2. For motors with other than 2:1 speed ratio, separate winding for each speed.
- E. Multispeed Motors: Separate winding for each speed.
- F. Rotor: Random-wound, squirrel cage.
- G. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- H. Temperature Rise: Match insulation rating.
- I. Insulation: Class F.
- J. Code Letter Designation:
 - 1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
 - 2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.
- K. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

- A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
- B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
 - 1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
 - 2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
 - 3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
 - 4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
- C. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

2.5 SINGLE-PHASE MOTORS

- A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
 - 1. Permanent-split capacitor.
 - 2. Split phase.
 - 3. Capacitor start, inductor run.
 - 4. Capacitor start, capacitor run.
- B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
- C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
- D. Motors 1/20 HP and Smaller: Shaded-pole type.
- E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION

SECTION 230516 - EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Flexible-hose packless expansion joints.
 - 2. Alignment guides and anchors.
 - 3. Pipe loops and swing connections.

1.3 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of the Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Product Data: For each type of product. . On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.

1.4 INFORMATIONAL SUBMITTALS

- A. Submittals shall comply with the requirements of the Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Welding certificates.

1.5 CLOSEOUT SUBMITTALS

- A. Submittals shall comply with the requirements of the Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Maintenance Data: For expansion joints to include in maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

- B. Pipe and Pressure-Vessel Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Compatibility: Products shall be suitable for piping service fluids, materials, working pressures, and temperatures.
- B. Capability: Products to absorb 200 percent of maximum axial movement between anchors.

2.2 PACKLESS EXPANSION JOINTS

A. Flexible-Hose Packless Expansion Joints:

1. 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.
2. Flexible Hose: Corrugated-metal inner hoses and braided outer sheaths.
3. Expansion Joints for Copper Tubing NPS 2 and Smaller: Copper-alloy fittings with solder-joint end connections.
 - a. Bronze hoses and double-braid bronze sheaths with 700 psig at 70 deg F and 500 psig at 450 deg F ratings.
4. Expansion Joints for Copper Tubing NPS 2-1/2 to NPS 4: Copper-alloy fittings with threaded end connections.
 - a. Stainless-steel hoses and double-braid, stainless-steel sheaths with 420 psig at 70 deg F and 315 psig at 450 deg F ratings.
5. Expansion Joints for Steel Piping NPS 2 and Smaller: Carbon-steel fittings with threaded end connections.
 - a. Stainless-steel hoses and double-braid, stainless-steel sheaths with 700 psig at 70 deg F and 515 psig at 600 deg F ratings.
6. Expansion Joints for Steel Piping NPS 2-1/2 to NPS 6: Carbon-steel fittings with flanged end connections.
 - a. Stainless-steel hoses and double-braid, stainless-steel sheaths with 275 psig at 70 deg F and 200 psig at 600 deg F ratings.

2.3 ALIGNMENT GUIDES AND ANCHORS

- A. Alignment Guides:

1. 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.

B. Anchor Materials:

1. Steel Shapes and Plates: ASTM A 36/A 36M.
2. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel hex head.
3. Washers: ASTM F 844, steel, plain, flat washers.
4. 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.
 - a. Stud: Threaded, zinc-coated carbon steel.
 - b. Expansion Plug: Zinc-coated steel.
 - c. Washer and Nut: Zinc-coated steel.

PART 3 - EXECUTION

3.1 EXPANSION JOINT INSTALLATION

- A. Install expansion joints of sizes matching sizes of piping in which they are installed.

3.2 PIPE LOOP AND SWING CONNECTION INSTALLATION

- A. Install pipe loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.
- B. Connect risers and branch connections to mains with at least five pipe fittings, including tee in main.
- C. Connect mains and branch connections to terminal units with at least four pipe fittings, including tee in main.

3.3 ALIGNMENT-GUIDE AND ANCHOR INSTALLATION

- A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.
- B. Attach guides to pipe, and secure guides to building structure.
- C. 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.
- D. Anchor Attachments:

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1. Anchor Attachment to Steel Pipe: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 2. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-69, Type 24; U bolts bolted to anchor.
- E. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.
1. Anchor Attachment to Steel Structural Members: Attach by welding.
 2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.
- F. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

END OF SECTION

SECTION 230517 - SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Sleeves.
2. Stack-sleeve fittings.
3. Sleeve-seal systems.
4. Sleeve-seal fittings.
5. Grout.

B. Related Requirements:

1. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

- C. Sustainable Design Requirements: Work included in this specification shall conform to the US Green Building Council LEED requirements listed in Section 018113.23 "Sustainable Design Requirements - LEED 2009 for Schools."

1.3 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of the Section 013300 "Submittal Procedures" and the individual sections specifying the work.

- B. Product Data: For each type of product indicated. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.

C. Sustainable Design Submittals:

1. Product Data: For sealants, indicating VOC content.
2. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.

1.4 INFORMATIONAL SUBMITTALS

- A. Submittals shall comply with the requirements of the Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Field quality-control reports.

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop collar.
- B. Galvanized-Steel Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

2.2 STACK-SLEEVE FITTINGS

- A. Description: Manufactured, cast-iron sleeve with integral cast flashing flange for use in waterproof floors and roofs. Include clamping ring, bolts, and nuts for membrane flashing.
 - 1. Underdeck Clamp: Clamping ring with setscrews.

2.3 SLEEVE-SEAL SYSTEMS

- A. Description:
 - 1. Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
 - 2. Designed to form a hydrostatic seal of 20-psig.
 - 3. Sealing Elements: EPDM-rubber or Nitrile (Buna N) interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size.
 - 4. Pressure Plates: Carbon steel or stainless steel.
 - 5. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, ASTM B 633 or stainless steel, of length required to secure pressure plates to sealing elements.

2.4 SLEEVE-SEAL FITTINGS

- A. Description:
 - 1. Manufactured plastic, sleeve-type, waterstop assembly, made for imbedding in concrete slab or wall.
 - 2. Plastic or rubber waterstop collar with center opening to match piping OD.

2.5 GROUT

- A. Description: Nonshrink, recommended for interior and exterior sealing openings in nonfire-rated walls or floors.
- B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.
 - 1. Sleeves are not required for core-drilled holes.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 4 inches above finished floor level.
 - 2. Using grout, seal space outside of sleeves in slabs and walls without sleeve-seal system.
- D. Install sleeves for pipes passing through interior partitions.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - 2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 - 3. Seal annular space between sleeve and piping or piping insulation; use sealants appropriate for size, depth, and location of joint.
- E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke-Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 078413 "Penetration Firestopping."

3.2 STACK-SLEEVE-FITTING INSTALLATION

- A. Install stack-sleeve fittings in new slabs as slabs are constructed.
 - 1. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 - 2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 076200 "Sheet Metal Flashing and Trim."
 - 3. Install section of cast-iron soil pipe to extend sleeve to 3 inches above finished floor level.
 - 4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 - 5. Using waterproof silicone sealant, seal space between top hub of stack-sleeve fitting and pipe.

- B. Fire-Resistance-Rated, Horizontal Assembly, 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."

3.3 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal-system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.4 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings as new walls and slabs are constructed.

- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

- C. Secure nailing flanges to concrete forms.

- D. Using grout, seal space around outside of sleeve-seal fittings.

3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:

1. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.

B. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.

3.6 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls Above Grade:
 - a. Sleeve-seal fittings.
2. Exterior Concrete Walls Below Grade:
 - a. Cast-iron pipe sleeves with sleeve-seal system or galvanized steel pipe sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
3. Concrete Slabs-on-Grade:
 - a. Cast-iron pipe sleeves with sleeve-seal system or galvanized steel pipe sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
4. Concrete Slabs Above Grade:
 - a. Stack-sleeve fittings.
5. Interior Partitions:
 - a. Galvanized-steel sheet.

END OF SECTION

SECTION 230518 - ESCUTCHEONS FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Escutcheons.
 - 2. Floor plates.

1.3 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of the Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Product Data: For each type of product indicated. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

- A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
- C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.

2.2 FLOOR PLATES

- A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
 - 1. Escutcheons for New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Insulated Piping: One-piece, stamped-steel type.
- C. Install floor plates for piping penetrations of equipment-room floors.
- D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
 - 1. New Piping: One-piece, floor-plate type.

3.2 FIELD QUALITY CONTROL

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

END OF SECTION

SECTION 230519 - METERS AND GAGES FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Liquid-in-glass thermometers.
2. Thermowells.
3. Dial-type pressure gages.
4. Gage attachments.
5. Test plugs.

B. Related Requirements:

1. Section 231123 "Facility Natural-Gas Piping" for gas meters.

1.3 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of the Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Product Data: For each type of product indicated. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.

1.4 INFORMATIONAL SUBMITTALS

- A. Submittals shall comply with the requirements of the Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Product Certificates: For each type of meter and gage. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.

1.5 CLOSEOUT SUBMITTALS

- A. Submittals shall comply with the requirements of the Section 013300 "Submittal Procedures" and the individual sections specifying the work.

- B. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.

PART 2 - PRODUCTS

2.1 LIQUID-IN-GLASS THERMOMETERS

A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:

1. Standard: ASME B40.200.
2. Case: Cast aluminum; 9-inch nominal size unless otherwise indicated.
3. Case Form: Adjustable angle unless otherwise indicated.
4. Tube: Glass with magnifying lens and blue or red organic liquid.
5. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
6. Window: Glass.
7. Stem: Aluminum and of length to suit installation.
 - a. Design for Thermowell Installation: Bare stem.
8. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.2 THERMOWELLS

A. Thermowells:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion in piping tee fitting.
3. Type: Stepped shank unless straight or tapered shank is indicated.
4. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
5. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
6. Bore: Diameter required to match thermometer bulb or stem.
7. Insertion Length: Length required to match thermometer bulb or stem.
8. Lagging Extension: Include on thermowells for insulated piping and tubing.
9. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

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

2.3 DIAL-TYPE PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Standard: ASME B40.100.

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2. Case: Liquid-filled, sealed type; cast aluminum or drawn steel; 4-1/2-inch nominal diameter.
3. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
4. Pressure Connection: Brass, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
5. Movement: Mechanical, with link to pressure element and connection to pointer.
6. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
7. Pointer: Dark-colored metal.
8. Window: Glass.
9. Ring: Metal.
10. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.4 GAGE ATTACHMENTS

- A. Snubbers: ASME B40.100, brass; with ASME B1.20.1 pipe threads and piston or porous-metal-type surge-dampening device. Include extension for use on insulated piping.
- B. Valves: Brass or stainless-steel needle, with ASME B1.20.1 pipe threads.

2.5 TEST PLUGS

- A. Description: Test-station fitting made for insertion in piping tee fitting.
- B. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.
- C. Thread Size: NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe thread.
- D. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.
- E. Core Inserts: Chlorosulfonated polyethylene synthetic or EPDM self-sealing rubber.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install thermowells with socket extending one-third of pipe diameter and in vertical position in piping tees.
- B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
- C. Install thermowells with extension on insulated piping.
- D. Fill thermowells with heat-transfer medium.
- E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

- F. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
- G. Install valve and snubber in piping for each pressure gage for fluids.
- H. Install test plugs in piping tees.
- I. Install thermometers in the following locations:
 - 1. Inlet and outlet of each hydronic zone.
 - 2. Inlet and outlet of each hydronic boiler.
 - 3. Inlet and outlet of each hydronic coil in air-handling units.
 - 4. Discharge of each pump.
- J. Install pressure gages in the following locations:
 - 1. Discharge of each pressure-reducing valve.
 - 2. Suction and discharge of each pump.

3.2 CONNECTIONS

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

3.3 ADJUSTING

- A. After installation, calibrate meters according to manufacturer's written instructions.
- B. Adjust faces of meters and gages to proper angle for best visibility.

3.4 THERMOMETER SCHEDULE

- A. Thermometers at inlet and outlet of each hydronic zone shall be the following:
 - 1. Industrial-style, liquid-in-glass type.
- B. Thermometers at inlet and outlet of each hydronic boiler shall be the following:
 - 1. Industrial-style, liquid-in-glass type.
- C. Thermometers at inlet and outlet of each hydronic coil in air-handling units and built-up central systems shall be the following:
 - 1. Industrial-style, liquid-in-glass type.
- D. Thermometers at inlets and outlets of each hydronic heat exchanger shall be the following:
 - 1. Industrial-style, liquid-in-glass type.

- E. Thermometers at inlet and outlet of each thermal-storage tank shall be the following:
 - 1. Industrial-style, liquid-in-glass type.
- F. Thermometer stems shall be of length to match thermowell insertion length.

3.5 THERMOMETER SCALE-RANGE SCHEDULE

- A. Scale Range for Chilled-Water Piping: 0 to 100 deg F.
- B. Scale Range for Heating, Hot-Water Piping: 20 to 240 deg F.

3.6 PRESSURE-GAGE SCHEDULE

- A. Pressure gages at discharge of each pressure-reducing valve shall be the following:
 - 1. Liquid-filled, sealed, direct-mounted, metal case.
- B. Pressure gages at inlet and outlet of each chiller chilled-water and condenser-water connection shall be the following:
 - 1. Liquid-filled, sealed, direct-mounted, metal case.
- C. Pressure gages at suction and discharge of each pump shall be the following:
 - 1. Liquid-filled, sealed, direct-mounted, metal case.

3.7 PRESSURE-GAGE SCALE-RANGE SCHEDULE

- A. Scale Range for Chilled-Water Piping: 0 to 100 psi.
- B. Scale Range for Heating, Hot-Water Piping: 0 to 100 psi.

END OF SECTION

SECTION 230523.11 - GLOBE VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Bronze globe valves.
 - 2. Iron globe valves.

1.3 DEFINITIONS

- A. CWP: Cold working pressure.

1.4 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Product Data: For each type of valve. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, grooves, and weld ends.
 - 3. Set globe valves closed to prevent rattling.
- 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.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:
 - 1. ASME B1.20.1 for threads for threaded-end valves.
 - 2. ASME B16.1 for flanges on iron valves.
 - 3. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
 - 4. ASME B16.18 for solder joint.
 - 5. ASME B31.1 for power piping valves.
 - 6. ASME B31.9 for building services piping valves.
- C. Refer to HVAC valve schedule articles for applications of valves.
- D. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- E. Valve Sizes: Same as upstream piping unless otherwise indicated.
- F. Valves in Insulated Piping: With 2-inch stem extensions.

2.2 BRONZE GLOBE VALVES

- A. Bronze Globe Valves, Class 125:
 - 1. Description:
 - a. Standard: MSS SP-80, Type 1.
 - b. CWP Rating: 200 psig.
 - c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
 - d. Ends: Threaded or solder joint.
 - e. Stem and Disc: Bronze.
 - f. Packing: Asbestos free.
 - g. Handwheel: Malleable iron.

2.3 IRON GLOBE VALVES

- A. Iron Globe Valves, Class 125:
 - 1. Description:
 - a. Standard: MSS SP-85, Type I.
 - b. CWP Rating: 200 psig.
 - c. Body Material: ASTM A 126, gray iron with bolted bonnet.

- d. Ends: Flanged.
- e. Trim: Bronze.
- f. Packing and Gasket: Asbestos free.
- g. Operator: Handwheel.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install valve tags. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for valve tags and schedules.

3.3 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.
- B. Select valves with the following end connections:
 - 1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules.
 - 2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules.
 - 3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
 - 4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
 - 5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules.
 - 6. For Steel Piping, NPS 5 and Larger: Flanged ends.

3.5 HEATING-WATER VALVE SCHEDULE

- A. Pipe NPS 2 and Smaller: Bronze globe valves, Class 125, with bronze disc, and soldered or threaded ends.
- B. Pipe NPS 2-1/2 and Larger: Iron globe valves, Class 125, with flanged ends.

END OF SECTION

SECTION 230523.12 - BALL VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Bronze ball valves.
 - 2. Steel ball valves.
 - 3. Iron ball valves.

1.3 DEFINITIONS

- A. CWP: Cold working pressure.

1.4 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Product Data: For each type of valve. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, and weld ends.
 - 3. Set ball valves open to minimize exposure of functional surfaces.
- B. Use the following precautions during storage:
 - 1. Maintain valve end protection.
 - 2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:
 - 1. ASME B1.20.1 for threads for threaded-end valves.
 - 2. ASME B16.1 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 B31.9 for building services piping valves.
- C. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.
- D. Refer to HVAC valve schedule articles for applications of valves.
- E. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- F. Valve Sizes: Same as upstream piping unless otherwise indicated.
- G. Valve Actuator Types:
 - 1. Gear Actuator: For quarter-turn valves NPS 4 and larger.
 - 2. Handlever: For quarter-turn valves smaller than NPS 4.
- H. Valves in Insulated Piping:
 - 1. Include 2-inch stem extensions.
 - 2. Extended operating handle of nonthermal-conductive material, and protective sleeves that allow operation of valves without breaking the vapor seals or disturbing insulation.
 - 3. Memory stops that are fully adjustable after insulation is applied.

2.2 BRONZE BALL VALVES

- A. Bronze Ball Valves, Two-Piece with Full Port and Stainless-Steel Trim:
 - 1. Description:
 - a. Standard: MSS SP-110.
 - b. SWP Rating: 150 psig.

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- c. CWP Rating: 600 psig.
- d. Body Design: Two piece.
- e. Body Material: Bronze.
- f. Ends: Threaded.
- g. Seats: PTFE.
- h. Stem: Stainless steel.
- i. Ball: Stainless steel, vented.
- j. Port: Full.

2.3 IRON BALL VALVES

A. Iron Ball Valves, Class 125:

1. Description:

- a. Standard: MSS SP-72.
- b. CWP Rating: 200 psig.
- c. Body Design: Split body.
- d. Body Material: ASTM A 126, gray iron.
- e. Ends: Flanged.
- f. Seats: PTFE.
- g. Stem: Stainless steel.
- h. Ball: Stainless steel.
- i. Port: Full.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install valve tags. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for valve tags and schedules.

3.3 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valves with specified SWP classes or CWP ratings are unavailable, the same types of valves with higher SWP classes or CWP ratings may be substituted.
- B. Select valves with the following end connections:
 - 1. For Copper Tubing, NPS 2 and Smaller: Threaded ends.
 - 2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
 - 3. For Steel Piping, NPS 2 and Smaller: Threaded ends.
 - 4. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.

3.4 HEATING-WATER VALVE SCHEDULE

- A. Pipe NPS 2 and Smaller: Bronze ball valves, two piece with stainless-steel trim, and full port.
- B. Pipe NPS 2-1/2 and Larger:
 - 1. Iron ball valves, Class 125.
 - a. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
 - 2. Steel ball valves, Class 150.

END OF SECTION

SECTION 230523.14 - CHECK VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Bronze swing check valves.
 - 2. Iron swing check valves.
 - 3. Iron, center-guided check valves.
 - 4. Iron, plate-type check valves.

1.3 DEFINITIONS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene copolymer rubber.
- C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
- D. SWP: Steam working pressure.

1.4 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Product Data: For each type of valve. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, grooves, and weld ends.
 - 3. 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.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:
 - 1. ASME B1.20.1 for threads for threaded-end valves.
 - 2. ASME B16.1 for flanges on iron valves.
 - 3. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
 - 4. ASME B31.9 for building services piping valves.
- C. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.
- D. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- E. Valve Sizes: Same as upstream piping unless otherwise indicated.
- F. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE SWING CHECK VALVES

- A. Bronze Swing Check Valves, Class 125:
 - 1. Description:
 - a. Standard: MSS SP-80, Type 3.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Horizontal flow.
 - d. Body Material: ASTM B 62, bronze.
 - e. Ends: Threaded.
 - f. Disc: Bronze or PTFE.

2.3 IRON SWING CHECK VALVES

A. Iron Swing Check Valves with Nonmetallic-to-Metal Seats, Class 125:

1. Description:

- a. Standard: MSS SP-71, Type I.
- b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
- c. NPS 14 to NPS 24, CWP Rating: 150 psig.
- d. Body Design: Clear or full waterway.
- e. Body Material: ASTM A 126, gray iron with bolted bonnet.
- f. Ends: Flanged.
- g. Trim: Composition.
- h. Seat Ring: Bronze.
- i. Disc Holder: Bronze.
- j. Disc: PTFE.
- k. Gasket: Asbestos free.

2.4 IRON, CENTER-GUIDED CHECK VALVES

A. Iron, Compact-Wafer, Center-Guided Check Valves, Class 125:

1. Description:

- a. Standard: MSS SP-125.
- b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
- c. NPS 14 to NPS 24, CWP Rating: 150 psig.
- d. Body Material: ASTM A 126, gray iron.
- e. Style: Compact wafer.
- f. Seat: Bronze, EPDM, or NBR.

2.5 IRON, PLATE-TYPE CHECK VALVES

A. Iron, Dual-Plate Check Valves, Class 125:

1. Description:

- a. Standard: API 594.
- b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
- c. NPS 14 to NPS 24, CWP Rating: 150 psig.
- d. Body Design: Wafer, spring-loaded plates.
- e. Body Material: ASTM A 126, gray iron.
- f. Seat: Bronze, EPDM, or NBR.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install check valves for proper direction of flow and as follows:
 - 1. Swing Check Valves: In horizontal position with hinge pin level.
 - 2. Center-Guided and Plate-Type Check Valves: In horizontal or vertical position, between flanges.
- F. Install valve tags. Comply with requirements for valve tags and schedules in Section 230553 "Identification for HVAC Piping and Equipment."

3.3 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valve applications are not indicated, use the following:

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1. Pump-Discharge Check Valves:
 - a. NPS 2 and Smaller: Bronze swing check valves with bronze or nonmetallic disc.
 - b. NPS 2-1/2 and Larger: Iron swing check valves with lever and weight or with spring or iron, center-guided, metal or resilient-seat check valves.
- B. If valves with specified SWP classes or CWP ratings are unavailable, the same types of valves with higher SWP classes or CWP ratings may be substituted.
- C. Select valves, except wafer types, with the following end connections:
 1. For Copper Tubing, NPS 2 and Smaller: Threaded ends.
 2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends.
 3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
 4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
 5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends.
 6. For Steel Piping, NPS 5 and Larger: Flanged ends.

END OF SECTION

SECTION 230523.15 - GATE VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Bronze gate valves.
 - 2. Iron gate valves.

1.3 DEFINITIONS

- A. CWP: Cold working pressure.
- B. NRS: Nonrising stem.
- C. OS&Y: Outside screw and yoke.
- D. RS: Rising stem.

1.4 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Product Data: For each type of valve. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, grooves, and weld ends.
 - 3. Set gate valves closed to prevent rattling.
- B. Use the following precautions during storage:

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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.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:
1. ASME B1.20.1 for threads for threaded-end valves.
 2. ASME B16.1 for flanges on iron valves.
 3. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
- C. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.
- D. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.
- E. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- F. Valve Sizes: Same as upstream piping unless otherwise indicated.
- G. RS Valves in Insulated Piping: With 2-inch stem extensions.
- H. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE GATE VALVES

- A. Bronze Gate Valves, RS, Class 125:
1. Description:
 - a. Standard: MSS SP-80, Type 2.
 - b. CWP Rating: 200 psig.
 - c. Body Material: ASTM B 62, 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, or aluminum.

2.3 IRON GATE VALVES

A. Iron Gate Valves, OS&Y, Class 125:

1. Description:

- a. Standard: MSS SP-70, Type I.
- b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
- c. NPS 14 to NPS 24, CWP Rating: 150 psig.
- d. Body Material: ASTM A 126, gray iron with bolted bonnet.
- e. Ends: Flanged.
- f. Trim: Bronze.
- g. Disc: Solid wedge.
- h. Packing and Gasket: Asbestos free.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install valve tags. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for valve tags and schedules.

3.3 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valve applications are not indicated, use the following:
 - 1. Shutoff Service: Gate valves.
- B. If valves with specified SWP classes or CWP ratings are unavailable, the same types of valves with higher SWP classes or CWP ratings may be substituted.
- C. Select valves, except wafer types, with the following end connections:
 - 1. For Copper Tubing, NPS 2 and Smaller: Threaded ends.
 - 2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends, except where threaded valve-end option is indicated in valve schedules below.
 - 3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
 - 4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
 - 5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends, except where threaded valve-end option is indicated in valve schedules below.
 - 6. For Steel Piping, NPS 5 and Larger: Flanged ends.

3.5 HEATING-WATER VALVE SCHEDULE

- A. Pipe NPS 2 and Smaller: Bronze valves, RS, Class 125 with threaded ends.
- B. Pipe NPS 2-1/2 and Larger: Iron gate valves, OS&Y, Class 125.

END OF SECTION

SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Metal framing systems.
4. Thermal-hanger shield inserts.
5. Fastener systems.
6. Pipe stands.
7. Equipment supports.

B. Related Sections:

1. Section 055000 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Section 230516 "Expansion Fittings and Loops for HVAC Piping" for pipe guides and anchors.
3. Section 230548.13 "Vibration Controls for HVAC" for vibration isolation devices.
4. Section 233113 "Metal Ducts" for duct hangers and supports.

1.3 DEFINITIONS

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

1.4 PERFORMANCE REQUIREMENTS

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

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3. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

1.5 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of the Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Product Data: For each type of product indicated. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.
- C. Shop Drawings: Show fabrication and installation details and include calculations for the following; include Product Data for components:
 1. Trapeze pipe hangers.
 2. Metal framing systems.
 3. Pipe stands.
 4. Equipment supports.

1.6 INFORMATIONAL SUBMITTALS

- A. Submittals shall comply with the requirements of the Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Welding certificates.

1.7 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.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

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

B. 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.

2.2 TRAPEZE PIPE HANGERS

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

2.3 METAL FRAMING SYSTEMS

A. Metal Framing Systems:

1. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
2. Standard: MFMA-4.
3. Channels: Continuous slotted steel channel with inturned lips.
4. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
6. Metallic Coating: Galvanized.

2.4 THERMAL-HANGER SHIELD INSERTS

- A. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.
- B. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- C. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- D. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.5 FASTENER SYSTEMS

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

2.6 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: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
- C. High-Type, Single-Pipe Stand:
 - 1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
 - 2. Base: Plastic or stainless steel.
 - 3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
 - 4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.
- D. High-Type, Multiple-Pipe Stand:
 - 1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
 - 2. Bases: One or more; plastic.
 - 3. Vertical Members: Two or more protective-coated-steel channels.
 - 4. Horizontal Member: Protective-coated-steel channel.
 - 5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.
- E. 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.

2.7 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.8 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
 - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
 - 2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.
- D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- E. Fastener System Installation:
 - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
 - 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- F. 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.
- G. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- H. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- I. 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.

- J. Install lateral bracing with pipe hangers and supports to prevent swaying.
- K. 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.
- L. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- M. 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.
- N. Insulated Piping:
 - 1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
 - 2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 3. Install MSS SP-58, Type 40, 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 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: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.
 - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
 - 5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

- B. Grouting: Place grout under supports for equipment and make bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER AND SUPPORT SCHEDULE

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

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- B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers, and metal framing systems and attachments for general service applications.
- F. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.
- G. Use padded hangers for piping that is subject to scratching.
- H. Use thermal-hanger shield inserts for insulated piping and tubing.
- I. 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 stationary pipes NPS 1/2 to NPS 30.
 - 2. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
 - 3. 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.
 - 4. 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.
 - 5. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
 - 6. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.
 - 7. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.
- J. 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.
- K. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

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1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 3. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
- L. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction, to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 10. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 11. 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.
- M. 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.
- N. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- O. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
- P. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

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END OF SECTION

SECTION 230548.13 - VIBRATION CONTROLS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Elastomeric isolation pads.
2. Housed-restrained-spring isolators.
3. Pipe-riser resilient supports.
4. Resilient pipe guides.
5. Spring hangers.
6. Vibration isolation equipment bases.

B. Related Requirements:

1. Section 210548.13 "Vibration Controls for Fire Suppression" for devices for fire-suppression equipment and systems.
2. Section 220548.13 "Vibration Controls for Plumbing" for devices for plumbing equipment and systems.

1.3 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.

- B. Product Data: For each type of product. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device type required.

C. Shop Drawings:

1. 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.

2. 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.

1.4 INFORMATIONAL SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Coordination Drawings: Show coordination of vibration isolation device installation for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.
- C. Qualification Data: For testing agency.
- D. Welding certificates.

1.5 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

PART 2 - PRODUCTS

2.1 ELASTOMERIC ISOLATION PADS

- A. Elastomeric Isolation Pads:
 1. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
 2. Size: Factory or field cut to match requirements of supported equipment.
 3. Pad Material: Oil and water resistant with elastomeric properties.
 4. Surface Pattern: Smooth pattern.
 5. Infused nonwoven cotton or synthetic fibers.
 6. Load-bearing metal plates adhered to pads.

2.2 HOUSED-RESTRAINED-SPRING ISOLATORS

- A. Freestanding, Steel, Open-Spring Isolators with Vertical-Limit Stop Restraint in Two-Part Telescoping Housing:
 1. 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.
 - b. Threaded top housing with adjustment bolt and cap screw to fasten and level equipment.
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.

2.3 PIPE-RISER RESILIENT SUPPORT

- A. Description: All-directional, acoustical pipe anchor consisting of two steel tubes separated by a minimum 1/2-inch-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 on isolation material providing equal isolation in all directions.

2.4 RESILIENT PIPE GUIDES

- A. Description: Telescopic arrangement of two steel tubes or post and sleeve arrangement separated by a minimum 1/2-inch-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.

2.5 SPRING HANGERS

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

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7. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
8. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

2.6 VIBRATION ISOLATION EQUIPMENT BASES

- A. 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 clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
 - a. Include supports for suction diffusers for pumps.
 2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. 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.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 VIBRATION CONTROL DEVICE INSTALLATION

- A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."
- B. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.

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3.3 VIBRATION ISOLATION EQUIPMENT BASES INSTALLATION

- A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."

END OF SECTION

SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

1.3 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of the Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Product Data: For each type of product. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.
- C. Samples: For color, letter style, and graphic representation required for each identification material and device.
- D. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- E. Valve numbering scheme.
- F. Valve Schedules: For each piping system to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

- A. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
 2. Letter Color: White.
 3. Background Color: Black.
 4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
 5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
 7. Fasteners: Stainless-steel rivets or self-tapping screws.
 8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.
- C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number, and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
- B. Letter Color: White.
- C. Background Color: Red.
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
- 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.

2.3 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction according to ASME A13.1.
- B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full 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; also include pipe size and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
 - 2. Lettering Size: Size letters according to ASME A13.1 for piping.
- E. Color: As scheduled.

2.4 DUCT LABELS

- A. Letter Color: Black.
- B. Background Color: Yellow.
- C. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- D. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- E. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings; also include duct size and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions or as separate unit on each duct label to indicate flow direction.

2.5 STENCILS

- A. Stencils for Piping:
 - 1. Lettering Size: Size letters according to ASME A13.1 for piping.
 - 2. Stencil Paint: Exterior, gloss, acrylic enamel in colors complying with recommendations in ASME A13.1 unless otherwise indicated. Paint may be in pressurized spray-can form.
 - 3. Identification Paint: Exterior, acrylic enamel Insert paint type in colors according to ASME A13.1 unless otherwise indicated. Paint may be in pressurized spray-can form.
- B. Stencils for Ducts:

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1. Lettering Size: Minimum letter height of 1-1/4 inches for viewing distances up to 15 feet and proportionately larger lettering for greater viewing distances.
2. Stencil Paint: Exterior, gloss, acrylic enamel. Paint may be in pressurized spray-can form.
3. Identification Paint: Exterior, acrylic enamel. Paint may be in pressurized spray-can form.

2.6 VALVE TAGS

- A. Description: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
1. Tag Material: Brass, 0.032-inch; stainless steel, 0.025-inch; aluminum, 0.032-inch; or anodized aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 2. Fasteners: Brass wire-link chain or beaded chain or S-hook.
- B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
1. Valve-tag schedule shall be included in operation and maintenance data.

2.7 WARNING TAGS

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

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

3.3 EQUIPMENT LABEL INSTALLATION

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

3.4 PIPE LABEL INSTALLATION

- A. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels, complying with ASME A13.1, with painted, color-coded bands or rectangles on each piping system.
 - 1. Identification Paint: Use for contrasting background.
 - 2. Stencil Paint: Use for pipe marking.
- B. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve and control device.
 - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations and on both sides of through walls, floors, ceilings, and inaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
 - 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
- C. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.
- D. Pipe Label Color Schedule:
 - 1. Chilled-Water Piping: White letters on a safety-green background.
 - 2. Heating Water Piping: Black letters on a safety-orange background.
 - 3. Refrigerant Piping: White letters on a safety-purple background.

3.5 DUCT LABEL INSTALLATION

- A. Install self-adhesive duct labels with permanent adhesive on air ducts.

- B. Stenciled Duct Label Option: Stenciled labels showing service and flow direction may be provided instead of plastic-laminated duct labels, at Installer's option.
- C. Locate labels near points where ducts enter into and exit from concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.6 VALVE-TAG INSTALLATION

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

3.7 WARNING-TAG INSTALLATION

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

END OF SECTION

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Balancing Air Systems:
 - a. Constant-volume air systems.
 - b. Variable-air-volume systems.
2. Balancing Hydronic Piping Systems:
 - a. Variable-flow hydronic systems.
3. Testing, Adjusting, and Balancing Equipment:
 - a. Heat exchangers.
 - b. Motors.
 - c. Condensing units.
 - d. Boilers.
 - e. Heat-transfer coils.
 - f. Radiant heating manifolds.
4. Testing, adjusting, and balancing existing systems and equipment.
5. Sound tests.
6. Control system verification.

- B. Sustainable Design Requirements: Work included in this specification shall conform to the US Green Building Council LEED requirements listed in Section 018113.23 "Sustainable Design Requirements - LEED 2009 for Schools."

1.3 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. BAS: Building automation systems.
- C. NEBB: National Environmental Balancing Bureau.

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- D. TAB: Testing, adjusting, and balancing.
- E. TABB: Testing, Adjusting, and Balancing Bureau.
- F. TAB Specialist: An independent entity meeting qualifications to perform TAB work.
- G. TDH: Total dynamic head.

1.4 PREINSTALLATION MEETINGS

- A. TAB Conference: If requested by the Owner, conduct a TAB conference at Project site 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.
 - 1. Minimum Agenda Items:
 - a. The Contract Documents examination report.
 - b. The TAB plan.
 - c. Needs for coordination and cooperation of trades and subcontractors.
 - d. Proposed procedures for documentation and communication flow.

1.5 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Sustainable Design Submittals:
 - 1. TAB Report: Documentation indicating that work complies with ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

1.6 INFORMATIONAL SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Qualification Data: Within 60 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.
- C. Contract Documents Examination Report: Within 90 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.
- D. 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.
- E. System Readiness Checklists: Within 90 days of Contractor's Notice to Proceed, submit system readiness checklists as specified in "Preparation" Article.

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- F. Examination Report: Submit a summary report of the examination review required in "Examination" Article.
- G. Certified TAB reports.
- H. Sample report forms.
- I. Instrument calibration reports, to include the following:
 - 1. Instrument type and make.
 - 2. Serial number.
 - 3. Application.
 - 4. Dates of use.
 - 5. Dates of calibration.

1.7 QUALITY ASSURANCE

- A. TAB Specialists Qualifications: Certified by AABC.
 - 1. TAB Field Supervisor: Employee of the TAB specialist and certified by AABC.
 - 2. TAB Technician: Employee of the TAB specialist and certified by AABC as a TAB technician.
- B. 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 as a TAB technician.
- C. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."
- D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.
- B. Examine installed systems for balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.

- C. Examine the approved submittals for HVAC systems and equipment.
- D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- E. Examine 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.
- 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 HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.
- I. Examine terminal units, such as variable-air- and constant-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.
- J. Examine strainers. Verify that startup screens have been replaced by permanent screens with indicated perforations.
- K. Examine control valves for proper installation for their intended function of throttling, diverting, or mixing fluid flows.
- L. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- M. Examine system pumps to ensure absence of entrained air in the suction piping.
- N. Examine operating safety interlocks and controls on HVAC equipment.
- O. Examining radiant heating manifold piping for correct radiant loop piping connections.
- P. 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.

3.2 PREPARATION

- A. Prepare a TAB plan that includes the following:

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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 HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:
1. Airside:
 - a. Duct systems are complete with terminals installed.
 - b. Volume, smoke, and fire dampers are open and functional.
 - c. Clean filters are installed.
 - d. Fans are operating, free of vibration, and rotating in correct direction.
 - e. Variable-frequency controllers' startup is complete and safeties are verified.
 - f. Automatic temperature-control systems are operational.
 - g. Ceilings are installed.
 - h. Windows and doors are installed.
 - i. Suitable access to balancing devices and equipment is provided.
 2. Hydronics:
 - a. Verify leakage and pressure tests on water distribution systems have been satisfactorily completed.
 - b. Piping is complete with terminals installed.
 - c. Water treatment is complete.
 - d. Systems are flushed, filled, and air purged.
 - e. Strainers are pulled, cleaned and properly installed.
 - f. Control valves are functioning per the sequence of operation.
 - g. Shutoff and balance valves have been verified to be 100 percent open.
 - h. Pumps are started and proper rotation is verified.
 - i. Pump gage connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.
 - j. Variable-frequency controllers' startup is complete and safeties are verified.
 - k. Suitable access to balancing devices and equipment is provided.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance", ASHRAE 111, NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems", or SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing" and in this Section.
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
 1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.

2. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 233300 "Air Duct Accessories."
 3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 230713 "Duct Insulation," Section 230716 "HVAC Equipment Insulation," and Section 230719 "HVAC Piping Insulation."
- C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Cross-check the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' "as-built" duct layouts.
- C. For variable-air-volume systems, develop a plan to simulate diversity.
- D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- E. 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.
- F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- G. Verify that motor starters are equipped with properly sized thermal protection.
- H. Check dampers for proper position to achieve desired airflow path.
- I. Check for airflow blockages.
- J. Check condensate drains for proper connections and functioning.
- K. Check for proper sealing of air-handling-unit components.
- L. Verify that air duct system is sealed as specified in Section 233113 "Metal Ducts."

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

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

- a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
 - b. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
 - c. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
 - d. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.
2. Measure fan static pressures as follows:
- a. Measure static pressure directly at the fan outlet or through the flexible connection.
 - b. Measure static pressure directly at the fan inlet or through the flexible connection.
 - c. Measure static pressure across each component that makes up the air-handling system.
 - d. Report artificial loading of filters at the time static pressures are measured.
3. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
4. Obtain approval from Owner for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
5. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.
1. Measure airflow of submain and branch ducts.
 2. Adjust submain and branch duct volume dampers for specified airflow.
 3. Re-measure each submain and branch duct after all have been adjusted.
- C. Adjust air inlets and outlets for each space to indicated airflows.
1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
 2. Measure inlets and outlets airflow.
 3. Adjust each inlet and outlet for specified airflow.
 4. Re-measure each inlet and outlet after they have been adjusted.
- D. Verify final system conditions.
1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to design if necessary.
 2. Re-measure and confirm that total airflow is within design.
 3. Re-measure all final fan operating data, rpms, volts, amps, and static profile.

4. Mark all final settings.
5. Test system in economizer mode. Verify proper operation and adjust if necessary.
6. Measure and record all operating data.
7. Record final fan-performance data.

3.6 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Adjust the variable-air-volume systems as follows:

1. Verify that the system static pressure sensor is located two-thirds of the distance down the duct from the fan discharge.
2. Verify that the system is under static pressure control.
3. Select the terminal unit that is most critical to the supply-fan airflow. Measure inlet static pressure, and adjust system static pressure control set point 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.
4. Calibrate and balance each terminal unit for maximum and minimum design airflow as follows:
 - a. Adjust controls so that terminal is calling for maximum airflow. Some controllers require starting with minimum airflow. Verify calibration procedure for specific project.
 - b. Measure airflow and adjust calibration factor as required for design maximum airflow. Record calibration factor.
 - c. When maximum airflow is correct, balance the air outlets downstream from terminal units.
 - d. Adjust controls so that terminal is calling for minimum airflow.
 - e. Measure airflow and adjust calibration factor as required for design minimum airflow. Record calibration factor. If no minimum calibration is available, note any deviation from design airflow.
 - f. On constant volume terminals, in critical areas where room pressure is to be maintained, verify that the airflow remains constant over the full range of full cooling to full heating. Note any deviation from design airflow or room pressure.
5. After terminals have been calibrated and balanced, test and adjust system for total airflow. Adjust fans to deliver total design airflows within the maximum allowable fan speed listed by fan manufacturer.
 - a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
 - b. Set terminals for maximum airflow. If system design includes diversity, adjust terminals for maximum and minimum airflow so that connected total matches fan selection and simulates actual load in the building.
 - c. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
 - d. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.

- e. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.
6. Measure fan static pressures as follows:
 - a. Measure static pressure directly at the fan outlet or through the flexible connection.
 - b. Measure static pressure directly at the fan inlet or through the flexible connection.
 - c. Measure static pressure across each component that makes up the air-handling system.
 - d. Report any artificial loading of filters at the time static pressures are measured.
7. Set final return and outside airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
 - a. Balance the return-air ducts and inlets the same as described for constant-volume air systems.
 - b. Verify that terminal units are meeting design airflow under system maximum flow.
8. Re-measure the inlet static pressure at the most critical terminal unit and adjust the system static pressure set point to the most energy-efficient set point to maintain the optimum system static pressure. Record set point and give to controls contractor.
9. Verify final system conditions as follows:
 - a. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to match design if necessary.
 - b. Re-measure and confirm that total airflow is within design.
 - c. Re-measure final fan operating data, rpms, volts, amps, and static profile.
 - d. Mark final settings.
 - e. Test system in economizer mode. Verify proper operation and adjust if necessary. Measure and record all operating data.
 - f. Verify tracking between supply and return fans.

3.7 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

- A. Prepare test reports for pumps, coils, and heat exchangers. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required coil and heat exchanger flow rates with pump design flow rate.
- B. Prepare schematic diagrams of systems' "as-built" piping layouts.
- C. In addition to requirements in "Preparation" Article, prepare hydronic systems for testing and balancing as follows:
 1. Check liquid level in expansion tank.
 2. Check highest vent for adequate pressure.
 3. Check flow-control valves for proper position.
 4. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
 5. Verify that motor starters are equipped with properly sized thermal protection.
 6. Check that air has been purged from the system.

3.8 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.
- B. Adjust the variable-flow hydronic system as follows:
 - 1. Verify that the differential-pressure sensor is located as indicated.
 - 2. Determine whether there is diversity in the system.
- C. For systems with no diversity:
 - 1. Adjust pumps to deliver total design gpm.
 - a. Measure total water flow.
 - 1) Position valves for full flow through coils.
 - 2) Measure flow by main flow meter, if installed.
 - 3) If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.
 - b. Measure pump TDH as follows:
 - 1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
 - 2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
 - 3) Convert pressure to head and correct for differences in gage heights.
 - 4) 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.
 - 5) With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.
 - c. Monitor motor performance during procedures and do not operate motor in an overloaded condition.
 - 2. Adjust flow-measuring devices installed in mains and branches to design water flows.
 - a. Measure flow in main and branch pipes.
 - b. Adjust main and branch balance valves for design flow.
 - c. Re-measure each main and branch after all have been adjusted.
 - 3. Adjust flow-measuring devices installed at terminals for each space to design water flows.
 - a. Measure flow at terminals.
 - b. Adjust each terminal to design flow.
 - c. Re-measure each terminal after it is adjusted.

- d. Position control valves to bypass the coil and adjust the bypass valve to maintain design flow.
 - e. Perform temperature tests after flows have been balanced.
4. For systems with pressure-independent valves at terminals:
 - a. Measure differential pressure and verify that it is within manufacturer's specified range.
 - b. Perform temperature tests after flows have been verified.
 5. For systems without pressure-independent valves or flow-measuring devices at terminals:
 - a. Measure and balance coils by either coil pressure drop or temperature method.
 - b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.
 6. Prior to verifying final system conditions, determine the system differential-pressure set point.
 7. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion open discharge valve 100 percent and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions.
 8. Mark final settings and verify that all memory stops have been set.
 9. Verify final system conditions as follows:
 - a. Re-measure and confirm that total water flow is within design.
 - b. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
 - c. Mark final settings.
 10. Verify that memory stops have been set.
- D. For systems with diversity:
1. Determine diversity factor.
 2. Simulate system diversity by closing required number of control valves, as approved by the design engineer.
 3. Adjust pumps to deliver total design gpm.
 - a. Measure total water flow.
 - 1) Position valves for full flow through coils.
 - 2) Measure flow by main flow meter, if installed.
 - 3) If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.
 - b. Measure pump TDH as follows:
 - 1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.

- 2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
 - 3) Convert pressure to head and correct for differences in gage heights.
 - 4) 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.
 - 5) With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.
- c. Monitor motor performance during procedures and do not operate motor in an overloaded condition.
4. Adjust flow-measuring devices installed in mains and branches to design water flows.
 - a. Measure flow in main and branch pipes.
 - b. Adjust main and branch balance valves for design flow.
 - c. Re-measure each main and branch after all have been adjusted.
 5. Adjust flow-measuring devices installed at terminals for each space to design water flows.
 - a. Measure flow at terminals.
 - b. Adjust each terminal to design flow.
 - c. Re-measure each terminal after it is adjusted.
 - d. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
 - e. Perform temperature tests after flows have been balanced.
 6. For systems with pressure-independent valves at terminals:
 - a. Measure differential pressure, and verify that it is within manufacturer's specified range.
 - b. Perform temperature tests after flows have been verified.
 7. For systems without pressure-independent valves or flow-measuring devices at terminals:
 - a. Measure and balance coils by either coil pressure drop or temperature method.
 - b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.
 8. Open control valves that were shut. Close a sufficient number of control valves that were previously open to maintain diversity, and balance terminals that were just opened.
 9. Prior to verifying final system conditions, determine system differential-pressure set point.
 10. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion open discharge valve 100 percent and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions.
 11. Mark final settings and verify that memory stops have been set.
 12. Verify final system conditions as follows:

- a. Re-measure and confirm that total water flow is within design.
- b. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
- c. Mark final settings.

13. Verify that memory stops have been set.

3.9 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.

3.10 PROCEDURES FOR CONDENSING UNITS

- A. Verify proper rotation of fans.
- B. Measure entering- and leaving-air temperatures.
- C. Record fan and motor operating data.

3.11 PROCEDURES FOR BOILERS

A. Hydronic Boilers:

1. Measure and record entering- and leaving-water temperatures.
2. Measure and record water flow.
3. Record relief valve pressure setting.

B. Steam Boilers:

1. Measure and record entering-water temperature.
2. Measure and record feed water flow.
3. Measure and record leaving-steam pressure and temperature.
4. Record relief valve pressure setting.

3.12 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 for major (more than 20 gpm) equipment coils, excluding unitary equipment such as reheat coils, unit heaters, and fan-coil units.
 4. Dry-bulb temperature of entering and leaving air.
 5. Wet-bulb temperature of entering and leaving air for cooling coils.
 6. Airflow.
- 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.
 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. 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.

3.13 SOUND TESTS

- A. After the systems are balanced and construction is Substantially Complete, measure and record sound levels at 15 locations as designated by the Architect.
- B. Instrumentation:
1. The sound-testing meter shall be a portable, general-purpose testing meter consisting of a microphone, processing unit, and readout.
 2. The sound-testing meter shall be capable of showing fluctuations at minimum and maximum levels, and measuring the equivalent continuous sound pressure level (LEQ).
 3. The sound-testing meter must be capable of using 1/3 octave band filters to measure mid-frequencies from 31.5 Hz to 8000 Hz.
 4. The accuracy of the sound-testing meter shall be plus or minus one decibel.
- C. Test Procedures:

1. Perform test at quietest background noise period. Note cause of unpreventable sound that affects test outcome.
2. Equipment should be operating at design values.
3. Calibrate the sound-testing meter prior to taking measurements.
4. Use a microphone suitable for the type of noise levels measured that is compatible with meter. Provide a windshield for outside or in-duct measurements.
5. Record a set of background measurements in dBA and sound pressure levels in the eight un-weighted octave bands 63 Hz to 8000 Hz (NC) with the equipment off.
6. Take sound readings in dBA and sound pressure levels in the eight un-weighted octave bands 63 Hz to 8000 Hz (NC) with the equipment operating.
7. Take readings no closer than 36 inches from a wall or from the operating equipment and approximately 60 inches from the floor, with the meter held or mounted on a tripod.
8. For outdoor measurements, move sound-testing meter slowly and scan area that has the most exposure to noise source being tested. Use A-weighted scale for this type of reading.

D. Reporting:

1. Report shall record the following:
 - a. Location.
 - b. System tested.
 - c. dBA reading.
 - d. Sound pressure level in each octave band with equipment on and off.
2. Plot sound pressure levels on NC worksheet with equipment on and off.

3.14 CONTROLS VERIFICATION

A. In conjunction with system balancing, perform the following:

1. Verify temperature control system is operating within the design limitations.
2. Confirm that the sequences of operation are in compliance with Contract Documents.
3. Verify that controllers are calibrated and function as intended.
4. Verify that controller set points are as indicated.
5. Verify the operation of lockout or interlock systems.
6. Verify the operation of valve and damper actuators.
7. Verify that controlled devices are properly installed and connected to correct controller.
8. Verify that controlled devices travel freely and are in position indicated by controller: open, closed, or modulating.
9. Verify location and installation of sensors to ensure that they sense only intended temperature, humidity, or pressure.

B. Reporting: Include a summary of verifications performed, remaining deficiencies, and variations from indicated conditions.

3.15 TOLERANCES

- A. Set HVAC system's airflow rates and water flow rates within the following tolerances:
 - 1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
 - 2. Air Outlets and Inlets: Plus or minus 10 percent.
 - 3. Heating-Water Flow Rate: Plus or minus 10 percent.
- B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.16 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 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 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.

3.17 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
 - 1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
 - 2. Include a list of instruments used for procedures, along with proof of calibration.
 - 3. Certify validity and accuracy of field data.
- B. Final Report Contents: In addition to certified field-report data, include the following:
 - 1. Pump curves.
 - 2. Fan curves.
 - 3. Manufacturers' test data.
 - 4. Field test reports prepared by system and equipment installers.
 - 5. Other information relative to equipment performance; do not include Shop Drawings and Product Data.
- C. General Report Data: In addition to form titles and entries, include the following data:
 - 1. Title page.
 - 2. Name and address of the TAB specialist.

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3. Project name.
 4. Project location.
 5. Architect'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. Data for terminal units, including manufacturer's name, type, size, and fittings.
 14. Notes to explain why certain final data in the body of reports vary from indicated values.
 15. Test conditions for fans and pump performance forms including the following:
 - a. Settings for outdoor-, return-, and exhaust-air dampers.
 - b. Conditions of filters.
 - c. Cooling coil, wet- and dry-bulb conditions.
 - d. Face and bypass damper settings at coils.
 - e. Fan drive settings including settings and percentage of maximum pitch diameter.
 - f. Inlet vane settings for variable-air-volume systems.
 - g. Settings for supply-air, static-pressure controller.
 - h. Other system operating conditions that affect performance.
- D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
1. Quantities of outdoor, supply, return, and exhaust airflows.
 2. Water and steam flow rates.
 3. Duct, outlet, and inlet sizes.
 4. Pipe and valve sizes and locations.
 5. Terminal units.
 6. Balancing stations.
 7. Position of balancing devices.
- E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:
1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and unit size.
 - e. Manufacturer's serial number.

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- f. Unit arrangement and class.
 - g. Discharge arrangement.
 - h. Sheave make, size in inches, and bore.
 - i. Center-to-center dimensions of sheave and amount of adjustments in inches.
 - j. Number, make, and size of belts.
 - k. Number, type, and size of filters.
2. Motor Data:
 - a. Motor make, and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.
 - f. Center-to-center dimensions of sheave and amount of adjustments in inches.
3. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Filter static-pressure differential in inches wg.
 - f. Preheat-coil static-pressure differential in inches wg.
 - g. Cooling-coil static-pressure differential in inches wg.
 - h. Heating-coil static-pressure differential in inches wg.
 - i. Outdoor airflow in cfm.
 - j. Return airflow in cfm.
 - k. Outdoor-air damper position.
 - l. Return-air damper position.
 - m. Vortex damper position.
- F. Apparatus-Coil Test Reports:
1. Coil Data:
 - a. System identification.
 - b. Location.
 - c. Coil type.
 - d. Number of rows.
 - e. Fin spacing in fins per inch o.c.
 - f. Make and model number.
 - g. Face area in sq. ft..
 - h. Tube size in NPS.
 - i. Tube and fin materials.
 - j. Circuiting arrangement.
 2. Test Data (Indicated and Actual Values):
 - a. Airflow rate in cfm.

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- b. Average face velocity in fpm.
 - c. Air pressure drop in inches wg.
 - d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
 - e. Return-air, wet- and dry-bulb temperatures in deg F.
 - f. Entering-air, wet- and dry-bulb temperatures in deg F.
 - g. Leaving-air, wet- and dry-bulb temperatures in deg F.
 - h. Water flow rate in gpm.
 - i. Water pressure differential in feet of head or psig.
 - j. Entering-water temperature in deg F.
 - k. Leaving-water temperature in deg F.
 - l. Refrigerant expansion valve and refrigerant types.
 - m. Refrigerant suction pressure in psig.
 - n. Refrigerant suction temperature in deg F.
 - o. Inlet steam pressure in psig.
- G. Gas-Fired Heat Apparatus 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 rpm.
 - 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-air temperature in deg F.
 - c. Leaving-air temperature in deg F.
 - d. Air temperature differential in deg F.
 - e. Entering-air static pressure in inches wg.
 - f. Leaving-air static pressure in inches wg.
 - g. Air static-pressure differential in inches wg.
 - h. Low-fire fuel input in Btu/h.
 - i. High-fire fuel input in Btu/h.
 - j. Manifold pressure in psig.
 - k. High-temperature-limit setting in deg F.
 - l. Operating set point in Btu/h.
 - m. Motor voltage at each connection.

- n. Motor amperage for each phase.
 - o. Heating value of fuel in Btu/h.
- H. Fan Test Reports: For supply, return, and exhaust fans, include the following:
- 1. Fan Data:
 - a. System identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and size.
 - e. Manufacturer's serial number.
 - f. Arrangement and class.
 - g. Sheave make, size in inches, and bore.
 - h. Center-to-center dimensions of sheave and amount of adjustments in inches.
 - 2. Motor Data:
 - a. Motor make, and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.
 - f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
 - g. Number, make, and size of belts.
 - 3. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Suction static pressure in inches wg.
- I. Round and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
- 1. Report Data:
 - a. System and air-handling-unit number.
 - b. Location and zone.
 - c. Traverse air temperature in deg F.
 - d. Duct static pressure in inches wg.
 - e. Duct size in inches.
 - f. Duct area in sq. ft..
 - g. Indicated airflow rate in cfm.
 - h. Indicated velocity in fpm.
 - i. Actual airflow rate in cfm.
 - j. Actual average velocity in fpm.
 - k. Barometric pressure in psig.

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J. Air-Terminal-Device Reports:

1. Unit Data:
 - a. System and air-handling unit identification.
 - b. Location and zone.
 - c. Apparatus used for test.
 - d. Area served.
 - e. Make.
 - f. Number from system diagram.
 - g. Type and model number.
 - h. Size.
 - i. Effective area in sq. ft..
2. Test Data (Indicated and Actual Values):
 - a. Airflow rate in cfm.
 - b. Air velocity in fpm.
 - c. Preliminary airflow rate as needed in cfm.
 - d. Preliminary velocity as needed in fpm.
 - e. Final airflow rate in cfm.
 - f. Final velocity in fpm.
 - g. Space temperature in deg F.

K. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:

1. Unit Data:
 - a. System and air-handling-unit identification.
 - b. Location and zone.
 - c. Room or riser served.
 - d. Coil make and size.
 - e. Flowmeter type.
2. Test Data (Indicated and Actual Values):
 - a. Airflow rate in cfm.
 - b. Entering-water temperature in deg F.
 - c. Leaving-water temperature in deg F.
 - d. Water pressure drop in feet of head or psig.
 - e. Entering-air temperature in deg F.
 - f. Leaving-air temperature in deg F.

L. 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.

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- 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 rpm.
 - 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.
- M. Radiant Manifold Reports:
1. Unit Data:
 - a. Manifold identification.
 - b. Location and zone.
 - c. Room served.
 - d. Number of radiant loops.
 - e. Flowmeter type.
 2. Test Data:
 - a. Total flow through manifold in gpm.
 - b. Flow through each loop in gpm.
 - c. Entering and leaving water temperatures in deg F.
 - d. Slab surface temperature at full flow.
 - e. Room temperature.
 - f. Room set point.
- N. Instrument Calibration Reports:

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

3.18 VERIFICATION OF TAB REPORT

- A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of Owner.
- B. Owner shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
- C. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
- D. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.
- E. If TAB work fails, proceed as follows:
 1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
 2. If the second final inspection also fails, Owner may contract the services of another TAB specialist to complete TAB work according to the Contract Documents and deduct the cost of the services from the original TAB specialist's final payment.
 3. If the second verification also fails, Owner may contact AABC Headquarters regarding the AABC National Performance Guaranty.
- F. Prepare test and inspection reports.

3.19 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 230713 - DUCT INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes insulating the following duct services:
 - 1. Indoor supply and outdoor air.
 - 2. Indoor return located in unconditioned space.
 - 3. Indoor, Type I, commercial, kitchen hood exhaust.
 - 4. Indoor oven and warewash exhaust.
 - 5. Indoor exhaust between isolation damper and penetration of building exterior.
- B. Related Sections:
 - 1. Section 230716 "HVAC Equipment Insulation."
 - 2. Section 230719 "HVAC Piping Insulation."
- C. Sustainable Design Requirements: Work included in this specification shall conform to the US Green Building Council LEED requirements listed in Section 018113.23 "Sustainable Design Requirements - LEED 2009 for Schools."

1.3 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any). On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.
- C. Sustainable Design Submittals:
 - 1. Product Data: For adhesives, indicating VOC content.
 - 2. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
 - 3. Product Data: For coatings, indicating VOC content.
 - 4. Laboratory Test Reports: For coatings, indicating compliance with requirements for low-emitting materials.

5. **Product Data:** For sealants, indicating VOC content.
6. **Laboratory Test Reports:** For sealants, indicating compliance with requirements for low-emitting materials.

1.4 INFORMATIONAL SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. **Qualification Data:** For qualified Installer.
- C. **Material Test Reports:** From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
- D. **Field quality-control reports.**

1.5 QUALITY ASSURANCE

- A. **Installer Qualifications:** Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. **Surface-Burning Characteristics:** For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to 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.

1.6 DELIVERY, STORAGE, AND HANDLING

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

1.7 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for

installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.8 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in "Duct Insulation Schedule, General," "Indoor Duct and Plenum Insulation Schedule," and "Aboveground, Outdoor Duct and Plenum Insulation Schedule" articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
- G. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 FIRE-RATED INSULATION SYSTEMS

- A. Fire-Rated Board: Structural-grade, press-molded, xonolite calcium silicate, fireproofing board suitable for operating temperatures up to 1700 deg F. Comply with ASTM C 656, Type II, Grade 6. Tested and certified to provide a 2-hour fire rating by an NRTL acceptable to authorities having jurisdiction.

- B. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is tested and certified to provide a 2-hour fire rating by an NRTL acceptable to authorities having jurisdiction.

2.3 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 - 1. Fiberglass 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 Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- C. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
 - 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 Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- D. PVC Jacket Adhesive: Compatible with PVC jacket.
 - 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 Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.4 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
 - 1. VOC Content: 300 g/L or less.
 - 2. Low-Emitting Materials: Mastic coatings 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 use on below ambient services.
 - 1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
 - 2. Service Temperature Range: Minus 20 to plus 180 deg F.
 - 3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
 - 4. Color: White.

- C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
 - 1. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
 - 2. Service Temperature Range: Minus 20 to plus 180 deg F.
 - 3. Solids Content: 60 percent by volume and 66 percent by weight.
 - 4. Color: White.

2.5 LAGGING ADHESIVES

- A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
 - 1. Adhesives shall have a VOC content of 50 g/L or less.
 - 2. Adhesive 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."
 - 3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct insulation.
 - 4. Service Temperature Range: 0 to plus 180 deg F.
 - 5. Color: White.

2.6 SEALANTS

- A. FSK and Metal Jacket Flashing Sealants:
 - 1. Materials shall be compatible with insulation materials, jackets, and substrates.
 - 2. Fire- and water-resistant, flexible, elastomeric sealant.
 - 3. Service Temperature Range: Minus 40 to plus 250 deg F.
 - 4. Color: Aluminum.
 - 5. Sealant shall have a VOC content of 420 g/L or less.
 - 6. 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."

- B. ASJ Flashing Sealants, and Vinyl and PVC Jacket Flashing Sealants:
 - 1. Materials shall be compatible with insulation materials, jackets, and substrates.
 - 2. Fire- and water-resistant, flexible, elastomeric sealant.

3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: White.
5. Sealant shall have a VOC content of 420 g/L or less.
6. 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."

2.7 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
 2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
 3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.8 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
1. Width: 3 inches.
 2. Thickness: 11.5 mils.
 3. Adhesion: 90 ounces force/inch in width.
 4. Elongation: 2 percent.
 5. Tensile Strength: 40 lbf/inch in width.
 6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
1. Width: 3 inches.
 2. Thickness: 6.5 mils.
 3. Adhesion: 90 ounces force/inch in width.
 4. Elongation: 2 percent.
 5. Tensile Strength: 40 lbf/inch in width.
 6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

2.9 SECUREMENTS

- A. Bands:

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1. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal or closed seal.
2. 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. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch-diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
2. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 - b. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
 - c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
3. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
 - a. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

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

D. Wire: 0.062-inch soft-annealed, stainless steel.

2.10 CORNER ANGLES

- A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.
- B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

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

3.3 GENERAL INSTALLATION REQUIREMENTS

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

3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
- J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- K. Install insulation with factory-applied jackets as follows:
 1. Draw jacket tight and smooth.
 2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
 - a. For below ambient services, apply vapor-barrier mastic over staples.
 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.
- L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
 1. Seal penetrations with flashing sealant.
 2. 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.
 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
 2. 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.
 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
 4. Seal jacket to wall flashing with flashing sealant.
- C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.
1. Comply with requirements in Section 078413 "Penetration Firestopping."
- E. Insulation Installation at Floor Penetrations:
1. Duct: For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
 2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 INSTALLATION OF MINERAL-FIBER INSULATION

- A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
 3. Install cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not overcompress insulation during installation.
 - e. Impale insulation over pins and attach speed washers.
 - f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
 - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.
 5. 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.
 6. 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.
- B. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
 3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not overcompress insulation during installation.
 - e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
 4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

- a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.
5. 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.
 6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.6 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."

3.7 FINISHES

- A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."
- B. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- C. Do not field paint aluminum or stainless-steel jackets.

3.8 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. Tests and Inspections:
 1. Inspect ductwork, 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 one location for each duct system defined in the "Duct Insulation Schedule, General" Article.

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

3.9 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:

1. Indoor, concealed supply and outdoor air.
2. Indoor, exposed supply and outdoor air.
3. Indoor, concealed return located in unconditioned space.
4. Indoor, exposed return located in unconditioned space.
5. Indoor, concealed, Type I, commercial, kitchen hood exhaust.
6. Indoor, exposed, Type I, commercial, kitchen hood exhaust.
7. Indoor, concealed oven and warewash exhaust.
8. Indoor, exposed oven and warewash exhaust.
9. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
10. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
11. Outdoor, concealed supply and return.
12. Outdoor, exposed supply and return.

B. Items Not Insulated:

1. Factory-insulated flexible ducts.
2. Factory-insulated plenums and casings.
3. Flexible connectors.
4. Vibration-control devices.
5. Factory-insulated access panels and doors.

3.10 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Concealed, round and flat-oval, supply-air duct insulation shall be the following:

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

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

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

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

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

D. Round and flat-oval, exhaust-air duct insulation shall be the following:

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

- E. Rectangular, supply-air duct insulation shall be one of the following:
 - 1. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.
 - 2. Mineral-Fiber Board: 1-1/2 inches thick and 2-lb/cu. ft. nominal density.
- F. Rectangular, return-air duct insulation shall be the following:
 - 1. Mineral-Fiber Board: 1-1/2 inches thick and 2-lb/cu. ft. nominal density.
- G. Rectangular, outdoor-air duct insulation shall be the following:
 - 1. Mineral-Fiber Board: 2 inches thick and 2-lb/cu. ft. nominal density.
- H. Rectangular, exhaust-air duct insulation between isolation damper and penetration of building exterior shall be the following:
 - 1. Mineral-Fiber Board: 2 inches thick and 2-lb/cu. ft. nominal density.
- I. Type I, Commercial, Kitchen Hood Exhaust Duct and Plenum Insulation: Fire-rated blanket or board; thickness as required to achieve 2-hour fire rating.

3.11 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Ducts and Plenums, Exposed:
 - 1. None.
 - 2. PVC: 20 mils thick.

END OF SECTION

SECTION 230716 - HVAC EQUIPMENT INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes insulating the following HVAC equipment that is not factory insulated:
 - 1. Heating, hot-water pumps.
 - 2. Air separators.
- B. Related Sections:
 - 1. Section 230713 "Duct Insulation."
 - 2. Section 230719 "HVAC Piping Insulation."
- C. Sustainable Design Requirements: Work included in this specification shall conform to the US Green Building Council LEED requirements listed in Section 018113.23 "Sustainable Design Requirements - LEED 2009 for Schools."

1.3 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any). On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.
- C. Sustainable Design Submittals:
 - 1. **Product Data:** For adhesives, indicating VOC content.
 - 2. **Laboratory Test Reports:** For adhesives, indicating compliance with requirements for low-emitting materials.
 - 3. **Product Data:** For coatings, indicating VOC content.
 - 4. **Laboratory Test Reports:** For coatings, indicating compliance with requirements for low-emitting materials.
 - 5. **Product Data:** For sealants, indicating VOC content.
 - 6. **Laboratory Test Reports:** For sealants, indicating compliance with requirements for low-emitting materials.

- D. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - 2. Detail removable insulation at equipment connections.
 - 3. Detail application of field-applied jackets.
 - 4. Detail field application for each equipment type.

1.4 INFORMATIONAL SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Qualification Data: For qualified Installer.
- C. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
- D. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to 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.

1.6 DELIVERY, STORAGE, AND HANDLING

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

1.7 COORDINATION

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

- B. Coordinate clearance requirements with equipment Installer for equipment insulation application.
- C. Coordinate installation and testing of heat tracing.

1.8 SCHEDULING

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

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- B. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- C. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. Provide insulation with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
- D. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 INSULATING CEMENTS

- A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.
- B. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.

2.3 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. Calcium Silicate Adhesive: Fibrous, sodium-silicate-based adhesive with a service temperature range of 50 to 800 deg F.
 - 1. Adhesives shall have a VOC content of 50 g/L or less.

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2. Adhesive 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."
- 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.
1. Adhesives shall have a VOC content of 50 g/L or less.
 2. Adhesive 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."
- D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
1. Fiberglass 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 Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.4 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
1. VOC Content: 300 g/L or less.
 2. Low-Emitting Materials: Mastic coatings 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. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
 2. Service Temperature Range: Minus 20 to plus 180 deg F.
 3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
 4. Color: White.

2.5 LAGGING ADHESIVES

- A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.

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1. Adhesives shall have a VOC content of 50 g/L or less.
2. Adhesive 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."
3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over equipment insulation.
4. Service Temperature Range: 0 to plus 180 deg F.
5. Color: White.

2.6 SEALANTS

A. Joint Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Permanently flexible, elastomeric sealant.
3. Service Temperature Range: Minus 100 to plus 300 deg F.
4. Color: White or gray.
5. Sealant shall have a VOC content of 420 g/L or less.
6. 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."

2.7 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.

2.8 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. Metal Jacket:

1. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
 - a. Sheet and roll stock ready for shop or field sizing or factory cut and rolled to size.
 - b. Finish and thickness are indicated in field-applied jacket schedules.
 - c. Moisture Barrier for Indoor Applications: 1-mil-thick, heat-bonded polyethylene and kraft paper.

d. Factory-Fabricated Fitting Covers:

- 1) Same material, finish, and thickness as jacket.
- 2) Preformed two-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.

2.9 TAPES

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

1. Width: 3 inches.
2. Thickness: 11.5 mils.
3. Adhesion: 90 ounces force/inch in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch in width.
6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

2.10 SECUREMENTS

A. Bands:

1. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal or closed seal.
2. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

2.11 CORNER ANGLES

A. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14.

PART 3 - EXECUTION

3.1 EXAMINATION

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

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

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

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

3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 4. Cover inserts with jacket material matching adjacent insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- K. Install insulation with factory-applied jackets as follows:
1. Draw jacket tight and smooth.
 2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
 - a. For below ambient services, apply vapor-barrier mastic over staples.
 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints.
- L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- O. For above ambient services, do not install insulation to the following:
1. Vibration-control devices.
 2. Testing agency labels and stamps.
 3. Nameplates and data plates.
 4. Manholes.
 5. Handholes.
 6. Cleanouts.

3.4 INSTALLATION OF EQUIPMENT, TANK, AND VESSEL INSULATION

- A. Mineral-Fiber, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of tank and vessel surfaces.
2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
3. Protect exposed corners with secured corner angles.
4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:
 - a. Do not weld anchor pins to ASME-labeled pressure vessels.
 - b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
 - c. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches o.c. in both directions.
 - d. Do not overcompress insulation during installation.
 - e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
 - f. Impale insulation over anchor pins and attach speed washers.
 - g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.
7. Stagger joints between insulation layers at least 3 inches.
8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

B. Insulation Installation on Pumps:

1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch centers, starting at corners. Install 3/8-inch- diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.
2. Fabricate boxes from galvanized steel or aluminum, at least 0.050 inch thick.

3. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

3.5 FIELD-APPLIED JACKET INSTALLATION

- A. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.6 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections: Inspect field-insulated equipment, 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 one location for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.
- C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.7 EQUIPMENT INSULATION SCHEDULE

- A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.
- B. Insulate indoor and outdoor equipment that is not factory insulated.
- C. Heating-hot-water pump insulation shall be the following:
 1. Mineral-Fiber Board: 2 inches thick and 2-lb/cu. ft. nominal density.
- D. Heating-hot-water expansion tank insulation shall be one of the following:
 1. Mineral-Fiber Board: 1 inch thick and 2-lb/cu. ft. nominal density.
 2. Mineral-Fiber Pipe and Tank: 1 inch thick.
- E. Heating-hot-water air-separator insulation shall be one of the following:
 1. Mineral-Fiber Board: 2 inches thick and 2-lb/cu. ft. nominal density.
 2. Mineral-Fiber Pipe and Tank: 2 inches thick.

END OF SECTION

SECTION 230719 - HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes insulating the following HVAC piping systems:
 - 1. Condensate drain piping.
 - 2. Heating hot-water piping.
 - 3. Refrigerant suction and hot-gas piping indoors and outdoors.
- B. Related Sections:
 - 1. Section 230713 "Duct Insulation."
 - 2. Section 230716 "HVAC Equipment Insulation."
- C. Sustainable Design Requirements: Work included in this specification shall conform to the US Green Building Council LEED requirements listed in Section 018113.23 "Sustainable Design Requirements - LEED 2009 for Schools."

1.3 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).
- C. Sustainable Design Submittals:
 - 1. **Product Data:** For adhesives, indicating VOC content.
 - 2. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
 - 3. **Product Data:** For coatings, indicating VOC content.
 - 4. Laboratory Test Reports: For coatings, indicating compliance with requirements for low-emitting materials.
 - 5. **Product Data:** For sealants, indicating VOC content.
 - 6. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.

- D. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - 2. Detail insulation application at pipe expansion joints for each type of insulation.
 - 3. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
 - 4. Detail removable insulation at piping specialties.
 - 5. Detail application of field-applied jackets.
 - 6. Detail application at linkages of control devices.

1.4 INFORMATIONAL SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 “Submittal Procedures” and the individual sections specifying the work.
- B. Qualification Data: For qualified Installer.
- C. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
- D. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing and inspecting agency acceptable to 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.

1.6 DELIVERY, STORAGE, AND HANDLING

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

1.7 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

1.8 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule" and "Outdoor, Aboveground Piping Insulation Schedule" Articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.
- G. Mineral-Fiber, Preformed Pipe Insulation:
 - 1. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

- H. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 INSULATING CEMENTS

- A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.
- B. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.

2.3 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
 - 1. Adhesives shall have a VOC content of 50 g/L or less.
 - 2. Adhesive 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."
- C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 - 1. Fiberglass 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 Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- D. 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. 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 Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- E. PVC Jacket Adhesive: Compatible with PVC jacket.

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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 Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.4 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
1. VOC Content: 300 g/L or less.
 2. Low-Emitting Materials: Mastic coatings 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 use on below-ambient services.
1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
 2. Service Temperature Range: Minus 20 to plus 180 deg F.
 3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
 4. Color: White.

2.5 LAGGING ADHESIVES

- A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
1. Adhesives shall have a VOC content of 50 g/L or less.
 2. Adhesive 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."
 3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
 4. Service Temperature Range: 0 to plus 180 deg F.
 5. Color: White.

2.6 SEALANTS

- A. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
1. Materials shall be compatible with insulation materials, jackets, and substrates.
 2. Fire- and water-resistant, flexible, elastomeric sealant.

3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: White.
5. Sealant shall have a VOC content of 420 g/L or less.
6. 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."

2.7 FACTORY-APPLIED JACKETS

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

2.8 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
 1. Adhesive: As recommended by jacket material manufacturer.
 2. Color: White.
 3. 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.
- C. Metal Jacket:
 1. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
 - a. Factory cut and rolled to size.
 - b. Finish and thickness are indicated in field-applied jacket schedules.
 - c. Moisture Barrier for Indoor Applications: 1-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.

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- 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: 60-mil- 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 stucco-embossed aluminum-foil facing.

2.9 TAPES

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

1. Width: 3 inches.
2. Thickness: 11.5 mils.
3. Adhesion: 90 ounces force/inch in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch in width.
6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

- B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1. Width: 2 inches.
2. Thickness: 6 mils.
3. Adhesion: 64 ounces force/inch in width.
4. Elongation: 500 percent.
5. Tensile Strength: 18 lbf/inch in width.

2.10 SECUREMENTS

- A. Bands:

1. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch wide with wing seal or closed seal.
2. 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. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

- C. Wire: 0.080-inch nickel-copper alloy or 0.062-inch soft-annealed, galvanized steel.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.

- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
1. Install insulation continuously through hangers and around anchor attachments.
 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
1. Draw jacket tight and smooth.
 2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
 - a. For below-ambient services, apply vapor-barrier mastic over staples.
 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- P. For above-ambient services, do not install insulation to the following:
1. Vibration-control devices.
 2. Testing agency labels and stamps.
 3. Nameplates and data plates.
 4. Manholes.
 5. Handholes.

6. Cleanouts.

3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
 1. Seal penetrations with flashing sealant.
 2. 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.
 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
 1. Seal penetrations with flashing sealant.
 2. 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.
 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
 4. Seal jacket to wall flashing with flashing sealant.
- C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
 1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.
- E. Insulation Installation at Floor Penetrations:
 1. Pipe: Install insulation continuously through floor penetrations.
 2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 GENERAL PIPE INSULATION INSTALLATION

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

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

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

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

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

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- B. Insulation Installation on Pipe Flanges:
 1. Install pipe insulation to outer diameter of pipe flange.
 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
 4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Insulation Installation on Pipe Fittings and Elbows:
 1. Install mitered sections of pipe insulation.
 2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- D. Insulation Installation on Valves and Pipe Specialties:
 1. Install preformed valve covers manufactured of same material as pipe insulation when available.
 2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 3. Install insulation to flanges as specified for flange insulation application.

4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.7 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

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

B. Insulation Installation on Pipe Flanges:

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

C. Insulation Installation on Pipe Fittings and Elbows:

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

D. Insulation Installation on Valves and Pipe Specialties:

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

3.8 FIELD-APPLIED JACKET INSTALLATION

- A. 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.
- B. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.9 FINISHES

- A. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

3.10 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. 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.
- C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.11 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
 - 1. Underground piping.
 - 2. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.12 INDOOR PIPING INSULATION SCHEDULE

- A. Condensate and Equipment Drain Water below 60 Deg F:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Flexible Elastomeric: 3/4 inch thick.
- B. Heating-Hot-Water Supply and Return, 140 Deg F and Below:
 - 1. NPS 1-1/4 and Smaller: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe, Type I: 1 inch thick.
 - 2. NPS 1-1/2 and Larger: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe, Type I: 1-1/2 inches thick.
- C. Heating-Hot-Water Supply and Return, above 140 Deg F:
 - 1. NPS 1-1/4 and Smaller: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe, Type I or II: 1-1/2 inches thick.
 - 2. NPS 1-1/2 and Larger: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe, Type I: 2 inches thick.
- D. Refrigerant Suction and Hot-Gas Piping:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Flexible Elastomeric: 1 inch thick.

3.13 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

- A. Refrigerant Suction and Hot-Gas Piping:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Flexible Elastomeric: 2 inches thick.

3.14 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. Piping, Concealed:

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1. None.
- C. Piping, Exposed Below 8-Feet Above Finished Floor:
1. PVC: 20 mils thick.

END OF SECTION

SECTION 230800 - COMMISSIONING OF HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes commissioning process requirements for HVAC&R systems, assemblies, and equipment.
- B. Related Sections:
 - 1. Section 019113 "General Commissioning Requirements" for general commissioning process requirements.
- C. Sustainable Design Requirements: Work included in this specification shall conform to the US Green Building Council LEED requirements listed in Section 018113.23 "Sustainable Design Requirements - LEED 2009 for Schools."

1.3 DEFINITIONS

- A. BAS: Building Automation System.
- B. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.
- C. CxA: Commissioning Authority.
- D. DDC: Direct Digital Controls.
- E. HVAC&R: Heating, Ventilating, Air Conditioning, and Refrigeration.
- F. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.
- G. TAB: Testing, Adjusting, and Balancing.

1.4 INFORMATIONAL SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.

- B. Prefunctional checklists of readiness.
- C. Prefunctional checklists of completion of installation, prestart, and startup activities.
- D. Qualifications Data: For HVAC testing technician.

1.5 QUALITY ASSURANCE

- A. HVAC&R Testing Technician Qualifications: Technicians to perform HVAC&R construction checklist verification tests, construction checklist verification test demonstrations, commissioning tests, and commissioning test demonstrations shall have the following minimum qualifications:
 - 1. Journeyman-level or equivalent skill level. Vocational School four-year program graduate or an Associates degree in mechanical systems, air conditioning, or similar field. Degree may be offset by three years' experience in servicing mechanical systems in the HVAC industry. Generally, required knowledge includes HVAC&R systems, electrical concepts, building operations, and application and use of tools and instrumentation to measure performance of HVAC&R equipment, assemblies, and systems.
 - 2. Minimum three years' experience installing, servicing, and operating systems manufactured by approved manufacturer.
 - a. National Environmental Balancing Bureau (NEBB) Certified Testing, Adjusting, and Balancing Technician.
 - b. Associated Air Balance Council (AABC) Certified Test and Balance Technician.
 - c. Owner retains the right to waive NEBB or AABC Certification.

1.6 CONTRACTOR'S RESPONSIBILITIES

- A. Perform commissioning tests at the direction of the CxA.
- B. Attend construction phase coordination meetings.
- C. Attend testing, adjusting, and balancing review and coordination meeting.
- D. Participate in HVAC&R systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.
- E. Provide information requested by the CxA for final commissioning documentation.
- F. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.

1.7 CxA'S RESPONSIBILITIES

- A. Provide Project-specific construction checklists and commissioning process test procedures for actual HVAC&R systems, assemblies, equipment, and components to be furnished and installed as part of the construction contract.
- B. Direct commissioning testing.
- C. Verify testing, adjusting, and balancing of Work are complete.
- D. Provide test data, inspection reports, and certificates in Systems Manual.

1.8 COMMISSIONING DOCUMENTATION

- A. Provide the following information to the CxA for inclusion in the commissioning plan:
 - 1. Plan for delivery and review of submittals, systems manuals, and other documents and reports.
 - 2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
 - 3. Process and schedule for completing construction checklists and manufacturer's prestart and startup checklists for HVAC&R systems, assemblies, equipment, and components to be verified and tested.
 - 4. Prefunctional checklists certifying that installation, prestart checks, and startup procedures have been completed.
 - 5. Prefunctional checklists certifying that HVAC&R systems, subsystems, equipment, and associated controls are ready for testing.
 - 6. Test and inspection reports and certificates.
 - 7. Corrective action documents.
 - 8. Verification of testing, adjusting, and balancing reports.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TESTING PREPARATION

- A. Certify that HVAC&R systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.
- B. Certify that HVAC&R instrumentation and control systems 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.

3.2 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 HVAC&R systems at the direction of the CxA.
 - 1. The CxA will notify testing and balancing Subcontractor 10 days in advance of the date of field verification. Notice will not include data points to be verified.
 - 2. The testing and balancing Subcontractor 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.

3.3 GENERAL TESTING REQUIREMENTS

- A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.
- B. Scope of HVAC&R testing shall include entire HVAC&R installation, from central equipment for heat generation and refrigeration through distribution systems to each conditioned space. Testing shall include measuring capacities and effectiveness of operational and control functions.

- C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.
- D. The CxA along with the HVAC&R Contractor, testing and balancing Subcontractor, and HVAC&R Instrumentation and Control Subcontractor shall prepare detailed testing plans, procedures, and checklists for HVAC&R systems, subsystems, and equipment.
- E. Tests will be performed using design conditions whenever possible.
- F. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.
- G. The CxA may direct that set points be altered when simulating conditions is not practical.
- H. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.
- I. If tests cannot be completed because of a deficiency outside the scope of the HVAC&R system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.
- J. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.4 HVAC&R systems, subsystems, and equipment Testing Procedures

- A. Boiler Testing and Acceptance Procedures: Testing requirements are specified in Section 235216 "Condensing Boilers." Provide submittals, test data, inspector record, and boiler certification to the CxA.
- B. HVAC&R Instrumentation and Control System Testing: Field testing plans and testing requirements are specified in Section 230900 "Instrumentation and Control for HVAC" and Section 230993 "Sequence of Operations for HVAC Controls." Assist the CxA with preparation of testing plans.
- C. Pipe system cleaning, flushing, hydrostatic tests, and chemical treatment requirements are specified in Division 23 piping Sections. HVAC&R Contractor shall prepare a pipe system cleaning, flushing, and hydrostatic testing plan. Provide cleaning, flushing, testing, and treating plan and final reports to the CxA. Plan shall include the following:
 - 1. Sequence of testing and testing procedures for each section of pipe to be tested, identified by pipe zone or sector identification marker. Markers shall be keyed to Drawings for each pipe sector, showing the physical location of each designated pipe test section. Drawings keyed to pipe zones or sectors shall be formatted to allow each section of

- piping to be physically located and identified when referred to in pipe system cleaning, flushing, hydrostatic testing, and chemical treatment plan.
2. Description of equipment for flushing operations.
 3. Minimum flushing water velocity.
 4. Tracking checklist for managing and ensuring that all pipe sections have been cleaned, flushed, hydrostatically tested, and chemically treated.
- D. Energy Supply System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of gas, hot-water and solar systems and equipment at the direction of the CxA. The CxA shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.
- E. Refrigeration System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of chillers, cooling towers, refrigerant compressors and condensers, heat pumps, and other refrigeration systems. The CxA shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.
- F. HVAC&R Distribution System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of air, steam, and hydronic distribution systems; special exhaust; and other distribution systems, including HVAC&R terminal equipment and unitary equipment.
- G. Vibration and Sound Tests: Provide technicians, instrumentation, tools, and equipment to test performance of vibration isolation and seismic controls.
- H. HVAC systems are shown on the contract drawings.

END OF SECTION

SECTION 230923 - DIRECT DIGITAL CONTROL (DDC) SYSTEM FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. DDC system for monitoring and controlling of HVAC systems.
2. Delivery of selected control devices to equipment and systems manufacturers for factory installation and to HVAC systems installers for field installation.

B. Related Requirements:

1. Section 230923.11 "Control Valves" for control valves that connect to the DDC system.
2. Section 230923.12 "Control Dampers" for control dampers that connect to the DDC system.
3. Section 230923.13 "Energy Meters" for thermal and electric power energy meters that connect to DDC systems.
4. Section 230923.14 "Flow Instruments" for flow meters that connect to the DDC system.
5. Section 230923.16 "Gas Instruments" for CO₂ sensors that connect to the DDC system.
6. Section 230923.19 "Moisture Instruments" for RH sensors that connect to the DDC system.
7. Section 230923.23 "Pressure Instruments" for pressure sensors and switches that connect to the DDC system.
8. Section 230923.27 "Temperature Instruments" for temperature sensors and switches that connect to the DDC system.
9. Communications Cabling:
 - a. Section 260523 "Control-Voltage Electrical Power Cables" for balanced twisted pair communications cable.
 - b. Section 271513 "Communications Copper Horizontal Cabling" for balanced twisted pair communications cable.
 - c. Section 271523 "Communications Optical Fiber Horizontal Cabling" for optical fiber communications cable.
10. Raceways:
 - a. Section 260533 "Raceways and Boxes for Electrical Systems" for raceways for low-voltage control cable.

- b. Section 270528 "Pathways for Communications Systems" for raceways for balanced twisted pair cabling and optical fiber cable.
- 11. Section 260553 "Identification for Electrical Systems" for identification requirements for electrical components.
- 12. Section 270553 "Identification for Communications Systems" for identification requirements for communications components.

1.3 DEFINITIONS

- A. Algorithm: A logical procedure for solving a recurrent mathematical problem. A prescribed set of well-defined rules or processes for solving a problem in a finite number of steps.
- B. Analog: A continuously varying signal value, such as current, flow, pressure, or temperature.
- C. BACnet Specific Definitions:
 - 1. BACnet: Building Automation Control Network Protocol, ASHRAE 135. A communications protocol allowing devices to communicate data over and services over a network.
 - 2. BACnet Interoperability Building Blocks (BIBBs): BIBB defines a small portion of BACnet functionality that is needed to perform a particular task. BIBBs are combined to build the BACnet functional requirements for a device.
 - 3. BACnet/IP: Defines and allows using a reserved UDP socket to transmit BACnet messages over IP networks. A BACnet/IP network is a collection of one or more IP subnetworks that share the same BACnet network number.
 - 4. BACnet Testing Laboratories (BTL): Organization responsible for testing products for compliance with ASHRAE 135, operated under direction of BACnet International.
 - 5. PICS (Protocol Implementation Conformance Statement): Written document that identifies the particular options specified by BACnet that are implemented in a device.
- D. Binary: Two-state signal where a high signal level represents "ON" or "OPEN" condition and a low signal level represents "OFF" or "CLOSED" condition. "Digital" is sometimes used interchangeably with "Binary" to indicate a two-state signal.
- E. Controller: Generic term for any standalone, microprocessor-based, digital controller residing on a network, used for local or global control. Three types of controllers are indicated: Network Controller, Programmable Application Controller, and Application-Specific Controller.
- F. Control System Integrator: An entity that assists in expansion of existing enterprise system and support of additional operator interfaces to I/O being added to existing enterprise system.
- G. COV: Changes of value.
- H. DDC System Provider: Authorized representative of, and trained by, DDC system manufacturer and responsible for execution of DDC system Work indicated.
- I. Distributed Control: Processing of system data is decentralized and control decisions are made at subsystem level. System operational programs and information are provided to remote

subsystems and status is reported back. On loss of communication, subsystems shall be capable of operating in a standalone mode using the last best available data.

- J. Gateway: Bidirectional protocol translator that connects control systems that use different communication protocols.
- K. HLC: Heavy load conditions.
- L. I/O: System through which information is received and transmitted. I/O refers to analog input (AI), binary input (BI), analog output (AO) and binary output (BO). Analog signals are continuous and represent control influences such as flow, level, moisture, pressure, and temperature. Binary signals convert electronic signals to digital pulses (values) and generally represent two-position operating and alarm status. "Digital," (DI and (DO), is sometimes used interchangeably with "Binary," (BI) and (BO), respectively.
- M. LAN: Local area network.
- N. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
- O. Mobile Device: A data-enabled phone or tablet computer capable of connecting to a cellular data network and running a native control application or accessing a web interface.
- P. MS/TP: Master-slave/token-passing, IEE 8802-3. Datalink protocol LAN option that uses twisted-pair wire for low-speed communication.
- Q. MTBF: Mean time between failures.
- R. Network Controller: Digital controller, which supports a family of programmable application controllers and application-specific controllers, that communicates on peer-to-peer network for transmission of global data.
- S. Network Repeater: Device that receives data packet from one network and rebroadcasts it to another network. No routing information is added to protocol.
- T. Peer to Peer: Networking architecture that treats all network stations as equal partners.
- U. POT: Portable operator's terminal.
- V. PUE: Performance usage effectiveness.
- W. RAM: Random access memory.
- X. RF: Radio frequency.
- Y. Router: Device connecting two or more networks at network layer.
- Z. Server: Computer used to maintain system configuration, historical and programming database.
- AA. TCP/IP: Transport control protocol/Internet protocol.

- BB. UPS: Uninterruptible power supply.
- CC. USB: Universal Serial Bus.
- DD. User Datagram Protocol (UDP): This protocol assumes that the IP is used as the underlying protocol.
- EE. VAV: Variable air volume.
- FF. WLED: White light emitting diode.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 “Submittal Procedures” and the individual sections specifying the work.
- B. Multiple Submissions:
 - 1. If multiple submissions are required to execute work within schedule, first submit a coordinated schedule clearly defining intent of multiple submissions. Include a proposed date of each submission with a detailed description of submittal content to be included in each submission.
 - 2. Clearly identify each submittal requirement indicated and in which submission the information will be provided.
 - 3. Include an updated schedule in each subsequent submission with changes highlighted to easily track the changes made to previous submitted schedule.
- C. Product Data: On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied. For each type of product include the following:
 - 1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
 - 2. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
 - 3. Product description with complete technical data, performance curves, and product specification sheets.
 - 4. Installation, operation and maintenance instructions including factors effecting performance.
 - 5. Bill of materials of indicating quantity, manufacturer, and extended model number for each unique product.

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- a. Workstations.
 - b. Servers.
 - c. Printers.
 - d. Routers.
 - e. DDC controllers.
 - f. Enclosures.
 - g. Electrical power devices.
 - h. UPS units.
 - i. Accessories.
 - j. Instruments.
 - k. Control dampers and actuators.
 - l. Control valves and actuators.
6. When manufacturer's product datasheets apply to a product series rather than a specific product model, clearly indicate and highlight only applicable information.
 7. Each submitted piece of product literature shall clearly cross reference specification and drawings that submittal is to cover.
- D. Software Submittal. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.
1. Cross-referenced listing of software to be loaded on each operator workstation, server, gateway, and DDC controller.
 2. Description and technical data of all software provided, and cross-referenced to products in which software will be installed.
 3. Operating system software, operator interface and programming software, color graphic software, DDC controller software, maintenance management software, and third-party software.
 4. Description of operator interface to alphanumeric and graphic programming.
 5. Description of each network communication protocol.
 6. Description of system database, including all data included in database, database capacity and limitations to expand database.
 7. 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.
- E. Shop Drawings:
1. General Requirements:
 - a. Include cover drawing with Project name, location, Owner, Architect, Contractor and issue date with each Shop Drawings submission.
 - b. Include a drawing index sheet listing each drawing number and title that matches information in each title block.
 2. Include plans, elevations, sections, and mounting details where applicable.
 3. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 4. Plan Drawings indicating the following:

- a. Screened backgrounds of walls, structural grid lines, HVAC equipment, ductwork and piping.
 - b. Room names and numbers with coordinated placement to avoid interference with control products indicated.
 - c. Each desktop workstation, server, gateway, router, DDC controller, control panel instrument connecting to DDC controller, and damper and valve connecting to DDC controller, included in Project.
 - d. Exact placement of products in rooms, ducts, and piping to reflect proposed installed condition.
 - e. Network communication cable and raceway routing.
 - f. Proposed routing of wiring, cabling, conduit, and tubing, coordinated with building services for review before installation.
5. Schematic drawings for each controlled HVAC system indicating the following:
- a. I/O points labeled with point names shown. Indicate instrument range, normal operating set points, and alarm set points. Indicate fail position of each damper and valve, if included in Project.
 - b. I/O listed in table format showing point name, type of device, manufacturer, model number, and cross-reference to product data sheet number.
 - c. A graphic showing location of control I/O in proper relationship to HVAC system.
 - d. Wiring diagram with each I/O point having a unique identification and indicating labels for all wiring terminals.
 - e. Unique identification of each I/O that shall be consistently used between different drawings showing same point.
 - f. Elementary wiring diagrams of controls for HVAC equipment motor circuits including interlocks, switches, relays and interface to DDC controllers.
 - g. Narrative sequence of operation.
6. Control panel drawings indicating the following:
- a. Panel dimensions, materials, size, and location of field cable, raceways, and wiring connections.
 - b. Interior subpanel layout, drawn to scale and showing all internal components, cabling and wiring raceways, nameplates and allocated spare space.
 - c. Front, rear, and side elevations and nameplate legend.
 - d. Unique drawing for each panel.
7. DDC system network riser diagram indicating the following:
- a. Each device connected to network with unique identification for each.
 - b. Interconnection of each different network in DDC system.
 - c. For each network, indicate communication protocol, speed and physical means of interconnecting network devices, such as copper cable type, or optical fiber cable type. Indicate raceway type and size for each.
 - d. Each network port for connection of an operator workstation or other type of operator interface with unique identification for each.
8. DDC system electrical power riser diagram indicating the following:

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- a. Each point of connection to field power with requirements (volts/phase/hertz/amperes/connection type) listed for each.
 - b. Each control power supply including, as applicable, transformers, power-line conditioners, transient voltage suppression and high filter noise units, DC power supplies, and UPS units with unique identification for each.
 - c. Each product requiring power with requirements (volts/phase/hertz/amperes/connection type) listed for each.
 - d. Power wiring type and size, race type, and size for each.
9. Monitoring and control signal diagrams indicating the following:
- a. Control signal cable and wiring between controllers and I/O.
 - b. Point-to-point schematic wiring diagrams for each product.
10. Color graphics indicating the following:
- a. Itemized list of color graphic displays to be provided.
 - b. For each display screen to be provided, a true color copy showing layout of pictures, graphics and data displayed.
 - c. Intended operator access between related hierarchical display screens.
- F. System Description:
1. Full description of DDC system architecture, network configuration, operator interfaces and peripherals, servers, controller types and applications, gateways, routers and other network devices, and power supplies.
 2. Complete listing and description of each report, log and trend for format and timing and events which initiate generation.
 3. System and product operation under each potential failure condition including, but not limited to, the following:
 - a. Loss of power.
 - b. Loss of network communication signal.
 - c. Loss of controller signals to inputs and outputs.
 - d. Operator workstation failure.
 - e. Server failure.
 - f. Gateway failure.
 - g. Network failure
 - h. Controller failure.
 - i. Instrument failure.
 - j. Control damper and valve actuator failure.
 4. Complete bibliography of documentation and media to be delivered to Owner.
 5. Description of testing plans and procedures.
 6. Description of Owner training.

1.6 INFORMATIONAL SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 “Submittal Procedures” and the individual sections specifying the work.
- B. Coordination Drawings:
 - 1. Plan drawings and corresponding product installation 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. Product installation location shown in relationship to room, duct, pipe and equipment.
 - b. Structural members to which products will be attached.
 - c. Wall-mounted instruments located in finished space showing relationship to light switches, fire-alarm devices and other installed devices.
 - d. Size and location of wall access panels for products installed behind walls and requiring access.
 - 2. Reflected ceiling plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - a. Ceiling components.
 - b. Size and location of access panels for products installed above inaccessible ceiling assemblies and requiring access.
 - c. Items penetrating finished ceiling including the following:
 - 1) Lighting fixtures.
 - 2) Air outlets and inlets.
 - 3) Speakers.
 - 4) Sprinklers.
 - 5) Access panels.
 - 6) Motion sensors.
 - 7) Pressure sensors.
 - 8) Temperature sensors and other DDC control system instruments.
- C. Qualification Data:
 - 1. Systems Provider Qualification Data:
 - a. Resume of project manager assigned to Project.
 - b. Resumes of application engineering staff assigned to Project.
 - c. Resumes of installation and programming technicians assigned to Project.
 - d. Resumes of service technicians assigned to Project.
 - e. Brief description of past project including physical address, floor area, number of floors, building system cooling and heating capacity and building's primary function.
 - f. Description of past project DDC system, noting similarities to Project scope and complexity indicated.

- g. Names of staff assigned to past project that will also be assigned to execute work of this Project.
 - h. Owner contact information for past project including name, phone number, and e-mail address.
 - i. Contractor contact information for past project including name, phone number, and e-mail address.
 - j. Architect and Engineer contact information for past project including name, phone number, and e-mail address.
- 2. Manufacturer's qualification data.
- 3. Testing agency's qualifications data.
- D. Product Certificates:
 - 1. Data Communications Protocol Certificates: Certifying that each proposed DDC system component complies with ASHRAE 135.
- E. Product Test Reports: For each product that requires testing to be performed by manufacturer.
- F. Source quality-control reports.
- G. Field quality-control reports.
- H. Sample Warranty: For manufacturer's warranty.

1.7 CLOSEOUT SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Operation and Maintenance Data: For DDC system to include in emergency, operation and maintenance manuals. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.
 - 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - a. Project Record Drawings of as-built versions of submittal Shop Drawings provided in electronic PDF format.
 - b. Testing and commissioning reports and checklists of completed final versions of reports, checklists, and trend logs.
 - c. As-built versions of submittal Product Data.
 - d. Names, addresses, e-mail addresses and 24-hour telephone numbers of Installer and service representatives for DDC system and products.
 - e. Operator's manual with procedures for operating control systems including logging on and off, handling alarms, producing point reports, trending data, overriding computer control and changing set points and variables.

- f. Programming manuals with description of programming language and syntax, of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.
- g. Engineering, installation, and maintenance manuals that explain how to:
 - 1) Design and install new points, panels, and other hardware.
 - 2) Perform preventive maintenance and calibration.
 - 3) Debug hardware problems.
 - 4) Repair or replace hardware.
- h. Documentation of all programs created using custom programming language including set points, tuning parameters, and object database.
- i. Backup copy of graphic files, programs, and database on electronic media such as DVDs or CDs.
- j. List of recommended spare parts with part numbers and suppliers.
- k. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.
- l. Complete original-issue copies of furnished software, including operating systems, custom programming language, operator workstation software, and graphics software.
- m. Licenses, guarantees, and warranty documents.
- n. Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.
- o. Owner training materials.

1.8 MAINTENANCE MATERIAL SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Furnish extra materials and parts that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
- C. Include product manufacturers' recommended parts lists for proper product operation over four-year period following warranty period. Parts list shall be indicated for each year.
- D. Furnish parts, as indicated by manufacturer's recommended parts list, for product operation during two-year period following warranty period.
- E. Furnish quantity indicated of matching product(s) in Project inventory for each unique size and type of following:
 - 1. Network Controller: One.
 - 2. Programmable Application Controller: One.
 - 3. Application-Specific Controller: One.
 - 4. Room and Outdoor Carbon Dioxide Sensor and Transmitter: One of each.
 - 5. Transformer: One of each size and type.
 - 6. DC Power Supply: One of each size and type.

1.9 QUALITY ASSURANCE

A. DDC System Manufacturer Qualifications:

1. Nationally recognized manufacturer of DDC systems and products.
2. DDC systems with similar requirements to those indicated for a continuous period of 10 years within time of bid.
3. DDC systems and products that have been successfully tested and in use on at least five past projects.
4. Having complete published catalog literature, installation, operation and maintenance manuals for all products intended for use.
5. Having full-time in-house employees for the following:
 - a. Product research and development.
 - b. Product and application engineering.
 - c. Product manufacturing, testing and quality control.
 - d. Technical support for DDC system installation training, commissioning and troubleshooting of installations.
 - e. Owner operator training.

B. DDC System Provider Qualifications:

1. Authorized representative of, and trained by, DDC system manufacturer.
2. In-place facility located within 50 miles of Project.
3. Demonstrated past experience with installation of DDC system products being installed for period within five consecutive years before time of bid.
4. Demonstrated past experience on five projects of similar complexity, scope and value.
5. Each person assigned to Project shall have demonstrated past experience.
6. Staffing resources of competent and experienced full-time employees that are assigned to execute work according to schedule.
7. Service and maintenance staff assigned to support Project during warranty period.
8. Product parts inventory to support on-going DDC system operation for a period of not less than 5 years after Substantial Completion.
9. DDC system manufacturer's backing to take over execution of Work if necessary to comply with requirements indicated. Include Project-specific written letter, signed by manufacturer's corporate officer, if requested.

1.10 WARRANTY

A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace products that fail in materials or workmanship within specified warranty period.

1. Failures shall be adjusted, repaired, or replaced at no additional cost or reduction in service to Owner.
2. Include updates or upgrades to software and firmware if necessary to resolve deficiencies.
 - a. Install updates only after receiving Owner's written authorization.

3. Warranty service shall occur during normal business hours and commence within 16 hours of Owner's warranty service request.
4. Warranty Period: Three years from date of Substantial Completion.
 - a. For Gateway: Three-year parts and labor warranty for each.

PART 2 - PRODUCTS

2.1 DDC SYSTEM DESCRIPTION

- A. Microprocessor-based monitoring and control including analog/digital conversion and program logic. A control loop or subsystem in which digital and analog information is received and processed by a microprocessor, and digital control signals are generated based on control algorithms and transmitted to field devices to achieve a set of predefined conditions.
 1. DDC system shall consist of a high-speed, peer-to-peer network of distributed DDC controllers, other network devices, operator interfaces, and software.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 WEB ACCESS

- A. DDC system shall be Web based.
 1. Web-Based Access to DDC System:
 - a. DDC system software shall be based on server thin-client architecture, designed around open standards of Web technology. DDC system server shall be accessed using a Web browser over DDC system network, using Owner's LAN, and remotely over Internet through Owner's LAN.
 - b. Intent of thin-client architecture is to provide operators complete access to DDC system via a Web browser. No special software other than a Web browser shall be required to access graphics, point displays, and trends; to configure trends, points, and controllers; and to edit programming.
 - c. Web access shall be password protected.

2.3 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: Products installed in ducts, equipment, and return-air paths shall comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 1. Flame-Spread Index: 25 or less.
 2. Smoke-Developed Index: 50 or less.
- B. DDC System Speed:

1. Response Time of Connected I/O:
 - a. AI point values connected to DDC system shall be updated at least every five seconds for use by DDC controllers. Points used globally shall also comply with this requirement.
 - b. BI point values connected to DDC system shall be updated at least every five seconds for use by DDC controllers. Points used globally shall also comply with this requirement.
 - c. AO points connected to DDC system shall begin to respond to controller output commands within two seconds. Global commands shall also comply with this requirement.
 - d. BO point values connected to DDC system shall respond to controller output commands within two seconds. Global commands shall also comply with this requirement.

2. Display of Connected I/O:
 - a. Analog point COV connected to DDC system shall be updated and displayed at least every 10 seconds for use by operator.
 - b. Binary point COV connected to DDC system shall be updated and displayed at least every 10 seconds for use by operator.
 - c. Alarms of analog and digital points connected to DDC system shall be displayed within 45 seconds of activation or change of state.
 - d. Graphic display refresh shall update within eight seconds.
 - e. Point change of values and alarms displayed from workstation to workstation when multiple operators are viewing from multiple workstations shall not exceed graphic refresh rate indicated.

- C. Network Bandwidth: Design each network of DDC system to include at least 30 percent available spare bandwidth with DDC system operating under normal and heavy load conditions indicated. Calculate bandwidth usage, and apply a safety factor to ensure that requirement is satisfied when subjected to testing under worst case conditions.

- D. DDC System Data Storage:
 1. Include capability to archive not less than 24 consecutive months of historical data for all I/O points connected to system, including alarms, event histories, transaction logs, trends and other information indicated.
 2. Local Storage:
 - a. Provide workstation with data storage indicated. Server(s) shall use IT industry standard database platforms and be capable of functions described in "DDC Data Access" Paragraph.

- E. DDC Data Access:
 1. When logged into the system, operator shall be able to also interact with any DDC controller connected to DDC system as required for functional operation of DDC system.
 2. System(s) shall be used for application configuration; for archiving, reporting and trending of data; for operator transaction archiving and reporting; for network

information management; for alarm annunciation; and for operator interface tasks and controls application management.

F. Future Expandability:

1. DDC system size shall be expandable to an ultimate capacity of at least two times total I/O points indicated.
2. Additional DDC controllers, I/O and associated wiring shall be all that is needed to achieve ultimate capacity. Initial network infrastructure shall be designed and installed to support ultimate capacity.
3. Operator interfaces installed initially shall not require hardware and software additions and revisions for ultimate capacity.

G. Input Point Displayed Accuracy: Input point displayed values shall meet following end-to-end overall system accuracy, including errors associated with meter, sensor, transmitter, lead wire or cable, and analog to digital conversion.

1. Energy:
 - a. Thermal: Within 5 percent of reading.
 - b. Electric Power: Within 1 percent of reading.
 - c. Requirements indicated on Drawings for meters not supplied by utility.
2. Flow:
 - a. Air: Within 5 percent of design flow rate.
 - b. Air (Terminal Units): Within 5 percent of design flow rate.
 - c. Water: Within 2 percent of design flow rate.
3. Gas:
 - a. Carbon Dioxide: Within 50 ppm.
 - b. Carbon Monoxide: Within 5 percent of reading.
 - c. Refrigerant: Within 50 ppm.
4. Moisture (Relative Humidity):
 - a. Air: Within 3 percent RH.
 - b. Space: Within 3 percent RH.
 - c. Outdoor: Within 3 percent RH.
5. Level: Within 5 percent of reading.
6. Pressure:
 - a. Air, Ducts and Equipment: 0.5 percent of instrument range.
 - b. Space: Within 0.25 percent of instrument range.
 - c. Water: Within 0.25 percent of instrument range.
7. Speed: Within percent of reading.
8. Temperature, Dry Bulb:

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- a. Air: Within 1 deg F.
 - b. Space: Within 1 deg F.
 - c. Outdoor: Within 1 deg F.
 - d. Heating Hot Water: Within 1 deg F.
 - e. Other Temperatures Not Indicated: Within 1 deg F.
- H. Precision of I/O Reported Values: Values reported in database and displayed shall have following precision:
1. Current:
 - a. Milliamperes: Nearest 1/100th of a milliampere.
 - b. Amperes: Nearest 1/10th of an ampere up to 100 A; nearest ampere for 100 A and more.
 2. Energy:
 - a. Electric Power:
 - 1) Rate (Watts): Nearest 1/10th of a watt through 1000 W.
 - 2) Rate (Kilowatts): Nearest 1/10th of a kilowatt through 1000 kW; nearest kilowatt above 1000 kW.
 - 3) Usage (Kilowatt-Hours): Nearest kilowatt through 10,000 kW; nearest 10 kW between 10,000 and 100,000 kW; nearest 100 kW for above 100,000 kW.
 - b. Thermal, Rate:
 - 1) Heating: For Btu/h, nearest Btu/h up to 1000 Btu/h; nearest 10 Btu/h between 1000 and 10,000 Btu/h; nearest 100 Btu/h for above 10,000 Btu/h. For Mbh, round to nearest Mbh up to 1000 Mbh; nearest 10 Mbh between 1000 and 10,000 Mbh; nearest 100 Mbh above 10,000 Mbh.
 - 2) Cooling: For tons, nearest ton up to 1000 tons; nearest 10 tons between 1000 and 10,000 tons; nearest 100 tons above 10,000 tons.
 - c. Thermal, Usage:
 - 1) Heating: For Btu, nearest Btu up to 1000 Btu; nearest 10 Btu between 1000 and 10,000 Btu; nearest 100 Btu for above 10,000 Btu. For Mbtu, round to nearest Mbtu up to 1000 Mbtu; nearest 10 Mbtu between 1000 and 10,000 Mbtu; nearest 100 Mbtu above 10,000 Mbtu.
 - 2) Cooling: For ton-hours, nearest ton-hours up to 1000 ton-hours; nearest 10 ton-hours between 1000 and 10,000 ton-hours; nearest 100 tons above 10,000 tons.
 3. Flow:
 - a. Air: Nearest 1/10th of a cfm through 100 cfm; nearest cfm between 100 and 1000 cfm; nearest 10 cfm between 1000 and 10,000 cfm; nearest 100 cfm above 10,000 cfm.

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- b. Water: Nearest 1/10th gpm through 100 gpm; nearest gpm between 100 and 1000 gpm; nearest 10 gpm between 1000 and 10,000 gpm; nearest 100 gpm above 10,000 gpm.
 4. Gas:
 - a. Carbon Dioxide (ppm): Nearest ppm.
 - b. Carbon Monoxide (ppm): Nearest ppm.
 - c. Refrigerant (ppm): Nearest ppm.
 5. Moisture (Relative Humidity):
 - a. Relative Humidity (Percentage): Nearest 1 percent.
 6. Pressure:
 - a. Air, Ducts and Equipment: Nearest 1/10th in. w.c..
 - b. Space: Nearest 1/100th in. w.c..
 - c. Water: Nearest 1/10 psig through 100 psig; nearest psig above 100 psig.
 7. Temperature:
 - a. Air, Ducts and Equipment: Nearest 1/10th of a degree.
 - b. Outdoor: Nearest degree.
 - c. Space: Nearest 1/10th of a degree.
 - d. Heating Hot Water: Nearest degree.
 8. Voltage: Nearest 1/10 volt up to 100 V; nearest volt above 100 V.
- I. Control Stability: Control variables indicated within the following limits:
 1. Flow:
 - a. Air, Ducts and Equipment, except Terminal Units: Within 5 percent of design flow rate.
 - b. Air, Terminal Units: Within 5 percent of design flow rate.
 - c. Water: Within 2 percent of design flow rate.
 2. Gas:
 - a. Carbon Dioxide: Within 50 ppm.
 - b. Carbon Monoxide: Within 5 percent of reading.
 3. Moisture (Relative Humidity):
 - a. Air: Within 5 percent RH.
 - b. Space: Within 5 percent RH.
 - c. Outdoor: Within 5 percent RH.
 4. Pressure:

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- a. Air, Ducts and Equipment: 0.5 percent of instrument range.
 - b. Space: Within 0.25 percent of instrument range.
 - c. Water: Within 0.25 percent of instrument range.
5. Temperature, Dry Bulb:
- a. Air: Within 0.5 deg F.
 - b. Space: Within 0.5 deg F.
 - c. Heating Hot Water: Within 1 deg F.
- J. Environmental Conditions for Controllers, Gateways, and Routers:
1. Products shall operate without performance degradation under ambient environmental temperature, pressure and humidity conditions encountered for installed location.
 - a. If product alone cannot comply with requirement, install product in a protective enclosure that is isolated and protected from conditions impacting performance. Enclosure shall be internally insulated, electrically heated, cooled and ventilated as required by product and application.
 2. Products shall be protected with enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. Products not available with integral enclosures complying with requirements indicated shall be housed in protective secondary enclosures. Installed location shall dictate the following NEMA 250 enclosure requirements:
 - a. Outdoors, Protected: Type 3.
 - b. Outdoors, Unprotected: Type 4.
 - c. Indoors, Heated with Filtered Ventilation: Type 1 or Type 2.
 - d. Indoors, Heated with Non-Filtered Ventilation: Type 2.
 - e. Indoors, Heated and Air Conditioned: Type 1.
 - f. Mechanical Equipment Rooms:
 - 1) Chiller and Boiler Rooms: Type 12.
 - 2) Air-Moving Equipment Rooms: Type 1.
 - g. Localized Areas Exposed to Washdown: Type 4.
 - h. Within Duct Systems and Air-Moving Equipment Not Exposed to Possible Condensation: Type 2.
 - i. Within Duct Systems and Air-Moving Equipment Exposed to Possible Condensation: Type 4.
- K. Environmental Conditions for Instruments and Actuators:
1. Instruments and actuators shall operate without performance degradation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified and encountered for installed location.
 - a. If instruments and actuators alone cannot comply with requirement, install instruments and actuators in protective enclosures that are isolated and protected

from conditions impacting performance. Enclosure shall be internally insulated, electrically heated and ventilated as required by instrument and application.

L. DDC System Reliability:

1. Design, install and configure DDC controllers, devices and to yield a MTBF of at least 40,000 hours, based on a confidence level of at least 90 percent. MTBF value shall include any failure for any reason to any part of products indicated.
2. If required to comply with MTBF indicated, include DDC system and product redundancy to maintain DCC system, and associated systems and equipment that are being controlled, operational and under automatic control.
3. Critical systems and equipment that require a higher degree of DDC system redundancy than MTBF indicated shall be indicated on Drawings.

M. Electric Power Quality:

1. Power-Line Surges:

- a. Protect DDC system products connected to ac power circuits from power-line surges.
- b. Do not use fuses for surge protection.

2. Power Conditioning:

- a. Protect susceptible DDC system products connected to ac power circuits from irregularities and noise rejection. Characteristics of power-line conditioner shall be as follows:
 - 1) At 85 percent load, output voltage shall not deviate by more than plus or minus 1 percent of nominal when input voltage fluctuates between minus 20 percent to plus 10 percent of nominal.
 - 2) During load changes from zero to full load, output voltage shall not deviate by more than plus or minus 3 percent of nominal.
 - 3) Accomplish full correction of load switching disturbances within five cycles, and 95 percent correction within two cycles of onset of disturbance.
 - 4) Total harmonic distortion shall not exceed 3-1/2 percent at full load.

3. Ground Fault: Protect products from ground fault by providing suitable grounding. Products shall not fail due to ground fault condition.

N. Backup Power Source:

1. HVAC systems and equipment served by a backup power source shall have associated DDC system products that control such systems and equipment also served from a backup power source.

O. UPS:

1. DDC system products powered by UPS units shall include the following:

- a. Desktop workstations.
- b. Printers.
- c. Servers.

P. Continuity of Operation after Electric Power Interruption:

1. Equipment and associated factory-installed controls, field-installed controls, electrical equipment, and power supply connected to building normal and backup power systems shall automatically return equipment and associated controls to operating state occurring immediately before loss of normal power, without need for manual intervention by operator when power is restored either through backup power source or through normal power if restored before backup power is brought online.

2.4 SYSTEM ARCHITECTURE

A. System architecture shall consist of no more than two levels of LANs.

1. Level one LAN shall connect network controllers and operator workstations.
2. Level one or Level two LAN shall connect programmable application controllers to other programmable application controllers, and to network controllers.
3. Level two LAN shall connect application-specific controllers to programmable application controllers and network controllers.
4. Level two LAN shall connect application-specific controllers to application-specific controllers.

B. DDC system shall consist of dedicated LANs that are not shared with other building systems and tenant data and communication networks.

C. System architecture shall be modular and have inherent ability to expand to not less than two times system size indicated with no impact to performance indicated.

D. System architecture shall perform modifications without having to remove and replace existing network equipment.

E. Number of LANs and associated communication shall be transparent to operator. All I/O points residing on any LAN shall be capable of global sharing between all system LANs.

F. System design shall eliminate dependence on any single device for system alarm reporting and control execution. Each controller shall operate independently by performing its' own control, alarm management and historical data collection.

G. Special Network Architecture Requirements:

1. Air-Handling Systems: For control applications of an air-handling system that consists of air-handling unit(s) and VAV or CAV terminal units, include a dedicated LAN of application-specific controllers serving VAV or CAV terminal units connected directly to controller that is controlling air-handling system air-handling unit(s). Create a DDC system LAN that aligns with air-handling system being controlled.

2.5 DDC SYSTEM OPERATOR INTERFACES

- A. Operator Means of System Access: Operator shall be able to access entire DDC system through any of multiple means, including, but not limited to, the following:
1. Desktop and portable workstation with hardwired connection through LAN port.
 2. Portable operator terminal with hardwired connection through LAN port.
 3. Portable operator workstation with wireless connection through LAN router.
 4. Mobile device and application with secured wireless connection through LAN router or cellular data service.
 5. Remote connection through web access.
- B. Access to system, regardless of operator means used, shall be transparent to operator.
- C. Network Ports: For hardwired connection of desktop or portable workstation. Network port shall be easily accessible, properly protected, clearly labeled, and installed at the following locations:
1. Each mechanical equipment room.
 2. Boiler room.
 3. Each different roof level with roof-mounted air-handling units or rooftop units.
- D. Desktop Workstations:
1. Connect to DDC system Level one LAN through a communications port directly on LAN or through a communications port on a DDC controller.
 2. Able to communicate with any device located on any DDC system LAN.
- E. Portable Workstations:
1. Connect to DDC system Level one LAN through a communications port directly on LAN or through a communications port on a DDC controller.
 2. Able to communicate with any device located on any DDC system LAN.
 3. Connect to DDC system Level two LAN through a communications port on an application-specific controller, or a room temperature sensor connected to an application-specific controller.
 4. Connect to system through a wireless router connected to Level one LAN.
 5. Connect to system through a cellular data service.
 6. Portable workstation shall be able to communicate with any device connected to any system LAN regardless of point of physical connection to system.
 7. Monitor, program, schedule, adjust set points, and report capabilities of I/O connected anywhere in system.
 8. Have dynamic graphic displays that are identical to desktop workstations.
- F. Mobile Device:
1. Connect to system through a wireless router connected to LAN and cellular data service.
 2. Able to communicate with any DDC controller connected to DDC system using a dedicated application and secure web access.

G. Critical Alarm Reporting:

1. Operator-selected critical alarms shall be sent by DDC system to notify operator of critical alarms that require immediate attention.
2. DDC system shall send alarm notification to multiple recipients that are assigned for each alarm.
3. DDC system shall notify recipients by any or all means, including e-mail, text message and prerecorded phone message to mobile and landline phone numbers.

H. Simultaneous Operator Use: Capable of accommodating up to five simultaneous operators that are accessing DDC system through any one of operator interfaces indicated.

2.6 NETWORK COMMUNICATION PROTOCOL

A. Network communication protocol(s) used throughout entire DDC system shall be open to Owner and available to other companies for use in making future modifications to DDC system.

B. ASHRAE 135 Protocol:

1. ASHRAE 135 communication protocol shall be sole and native protocol used throughout entire DDC system.
2. DDC system shall not require use of gateways except to integrate HVAC equipment and other building systems and equipment, not required to use ASHRAE 135 communication protocol.
3. If used, gateways shall connect to DDC system using ASHRAE 135 communication protocol and Project object properties and read/write services indicated by interoperability schedule.
4. Operator workstations, controllers and other network devices shall be tested and listed by BACnet Testing Laboratories.

C. Industry Standard Protocols:

1. DDC system shall use any one or a combination of the following industry standard protocols for network communication while complying with other DDC system requirements indicated:
 - a. ASHRAE 135.
2. Operator workstations and network controllers shall communicate through ASHRAE 135 protocol.
3. Portions of DDC system networks using ASHRAE 135 communication protocol shall be an open implementation of network devices complying with ASHRAE 135. Network devices shall be tested and listed by BACnet Testing Laboratories.

2.7 DESKTOP WORKSTATIONS

A. Description: A tower or all-in-one computer designed for normal use at a single, semipermanent location.

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B. Performance Requirements:

1. Performance requirements may dictate equipment exceeding minimum requirements indicated.
2. Energy Star compliant.

C. Personal Computer:

1. Minimum Processor Speed: 2.0 GHz.
2. RAM:
 - a. Capacity: 4 GB.
3. Hard Drive:
 - a. Media: Rotating disc, nominal rotational speed of 7200 rpm.
 - b. Number of Hard Drives: One.
 - c. Capacity: 500 GB.
4. Video Card:
 - a. Resolution: 1920 by 1080 pixels.
5. Network Interface Card: Include card with connection, as applicable.
 - a. 10-100-1000 base TX Ethernet with RJ45 connector port.

D. Keyboard:

1. 101 enhanced keyboard.
2. Full upper- and lowercase ASCII keyset, numeric keypad, dedicated cursor control keypad, and 12 programmable function keys.

E. Pointing Device:

1. Either a two- or three-button mouse.

F. Flat Panel Display Monitor.

2.8 PORTABLE WORKSTATIONS

A. Description: A self-contained computer designed to allow for normal use in different locations and conditions.

B. Performance Requirements:

1. Performance requirements may dictate equipment exceeding minimum requirements indicated.
2. Energy Star compliant.
3. Hardware and software shall support local down-loading to DDC controllers.

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4. Data transfer rate to DDC controller shall be at network speed.
- C. Processor:
1. Minimum Processor Speed: 2.0 GHz.
 2. RAM:
 - a. Capacity: 4 GB.
 3. Hard Drive:
 - a. Number of Hard Drives: One.
 - b. Capacity: 500 GB.
- D. Input and Output Ports:
1. Four USB 3.0 ports.
 2. Ethernet port.
- E. Battery:
1. Battery life of at least three years.
 2. Battery charge time of less than three hours.
- F. Keyboard:
1. 85-key backlit keyboard.
 2. Full upper- and lowercase ASCII keyset.
- G. Integral Pointing Device: Touchpad with two buttons. Gesture enabled.
- H. Display:
1. Antiglare screen.
 2. 1920 by 1080 pixel resolution.
- I. Network Interfaces:
1. Network Interface Card: Include card with connection, as application.
 - a. 10-100-1000 base TX Ethernet with RJ45 connector port.
- J. Accessories:
1. Nylon carrying case.
 2. Optical mouse.
 3. Category 6a patch cable. Minimum cable length shall be 6 feet.

2.9 PRINTERS

A. Color Inkjet Printer:

1. Inkjet technology with true four-color printing (black, cyan, magenta, and yellow).
2. Print quality of 1200 by 600 dots per inch with black on inkjet paper and 4800 by 1200 dots per inch color printing on premium photo paper.

2.10 SYSTEM SOFTWARE

A. System Software Minimum Requirements:

1. Real-time multitasking and multiuser 64-bit operating system that allows concurrent multiple operator workstations operating and concurrent execution of multiple real-time programs and custom program development.
2. Operating system shall be capable of operating DOS and Microsoft Windows applications.
3. Network communications software shall manage and control multiple network communications to provide exchange of global information and execution of global programs.
4. Operator interface software shall include day-to-day operator transaction processing, alarm and report handling, operator privilege level and data segregation control, custom programming, and online data modification capability.
5. Scheduling software shall schedule centrally based time and event, temporary, and exception day programs.

B. Operator Interface Software:

1. Minimize operator training through use of English language prorating and English language point identification.
2. Minimize use of a typewriter-style keyboard through use of a pointing device similar to a mouse.
3. Operator sign-off shall be a manual operation or, if no keyboard or mouse activity takes place, an automatic sign-off.
4. Automatic sign-off period shall be programmable from one to 60 minutes in one-minute increments on a per operator basis.
5. Security Access:
 - a. Operator access to DDC system shall be under password control.
 - b. An alphanumeric password shall be field assignable to each operator.
 - c. Operators shall be able to access DDC system by entry of proper password.
 - d. Operator password shall be same regardless of which computer or other interface means is used.
 - e. Additions or changes made to passwords shall be updated automatically.
 - f. Each operator shall be assigned an access level to restrict access to data and functions the operator is cable of performing.
 - g. Software shall have at least five access levels.

- h. Each menu item shall be assigned an access level so that a one-for-one correspondence between operator assigned access level(s) and menu item access level(s) is required to gain access to menu item.
 - i. Display menu items to operator with those capable of access highlighted. Menu and operator access level assignments shall be online programmable and under password control.
- 6. Operators shall be able to perform commands including, but not limited to, the following:
 - a. Start or stop selected equipment.
 - b. Adjust set points.
 - c. Add, modify, and delete time programming.
 - d. Enable and disable process execution.
 - e. Lock and unlock alarm reporting for each point.
 - f. Enable and disable totalization for each point.
 - g. Enable and disable trending for each point.
 - h. Override control loop set points.
 - i. Enter temporary override schedules.
 - j. Define holiday and event schedules.
 - k. Change time and date.
 - l. Enter and modify analog alarm limits.
 - m. Enter and modify analog warning limits.
 - n. View limits.
 - o. Enable and disable demand limiting.
 - p. Enable and disable duty cycle.
 - q. Display logic programming for each control sequence.
- 7. Reporting:
 - a. Generated automatically and manually.
 - b. Sent to displays, printers and disk files.
 - c. Types of Reporting:
 - 1) General listing of points.
 - 2) List points currently in alarm.
 - 3) List of off-line points.
 - 4) List points currently in override status.
 - 5) List of disabled points.
 - 6) List points currently locked out.
 - 7) List of items defined in a "Follow-Up" file.
 - 8) List weekly schedules.
 - 9) List holiday programming.
 - 10) List of limits and deadbands.
- 8. Summaries: For specific points, for a logical point group, for an operator selected group(s), or for entire system without restriction due to hardware configuration.

C. Graphic Interface Software:

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1. Include a full interactive graphical selection means of accessing and displaying system data to operator. Include at least five levels with the penetration path operator assignable (for example, site, building, floor, air-handling unit, and supply temperature loop). Native language descriptors assigned to menu items are to be operator defined and modifiable under password control.
2. Include a hierarchical-linked dynamic graphic operator interface for accessing and displaying system data and commanding and modifying equipment operation. Interface shall use a pointing device with pull-down or penetrating menus, color and animation to facilitate operator understanding of system.
3. Include at least 10 levels of graphic penetration with the hierarchy operator assignable.
4. Descriptors for graphics, points, alarms and such shall be modified through operator's workstation under password control.
5. Graphic displays shall be online user definable and modifiable using the hardware and software provided.
6. Data to be displayed within a graphic shall be assignable regardless of physical hardware address, communication or point type.
7. Graphics are to be online programmable and under password control.
8. Points may be assignable to multiple graphics where necessary to facilitate operator understanding of system operation.
9. Graphics shall also contain software points.
10. Penetration within a graphic hierarchy shall display each graphic name as graphics are selected to facilitate operator understanding.
11. Back-trace feature shall permit operator to move upward in the hierarchy using a pointing device. Back trace shall show all previous penetration levels. Include operator with option of showing each graphic full screen size with back trace as horizontal header or by showing a "stack" of graphics, each with a back trace.
12. Display operator accessed data on the monitor.
13. Operator shall select further penetration using pointing device to click on a site, building, floor, area, equipment, and so on. Defined and linked graphic below that selection shall then be displayed.
14. Include operator with means to directly access graphics without going through penetration path.
15. Dynamic data shall be assignable to graphics.
16. Display points (physical and software) with dynamic data provided by DDC system with appropriate text descriptors, status or value, and engineering unit.
17. Use color, rotation, or other highly visible means, to denote status and alarm states. Color shall be variable for each class of points, as chosen by operator.
18. Points shall be dynamic update rates on a per point basis.
19. For operators with appropriate privilege, points shall be commanded directly from display using pointing device.
 - a. For an analog command point such as set point, current conditions and limits shall be displayed and operator can position new set point using pointing device.
 - b. For a digital command point such as valve position, valve shall show its current state such as open or closed and operator could select alternative position using pointing device.
 - c. Keyboard equivalent shall be available for those operators with that preference.
20. Operator shall be able to split or resize viewing screen into quadrants to show one graphic on one quadrant of screen and other graphics or spreadsheet, bar chart, word

processing, curve plot and other information on other quadrants on screen. This feature shall allow real-time monitoring of one part of system while displaying other parts of system or data to better facilitate overall system operation.

21. Graphic generation software shall allow operator to add, modify, or delete system graphic displays.
 - a. Include libraries of symbols depicting HVAC symbols such as fans, coils, filters, dampers, valves pumps, and electrical symbols.
 - b. Graphic development package shall use a pointing device in conjunction with a drawing program to allow operator to perform the following:
 - 1) Define background screens.
 - 2) Define connecting lines and curves.
 - 3) Locate, orient and size descriptive text.
 - 4) Define and display colors for all elements.
 - 5) Establish correlation between symbols or text and associated system points or other displays.

D. Project-Specific Graphics: Graphics documentation including, but not limited to, the following:

1. Site plan showing each building, and additional site elements, which are being controlled or monitored by DDC system.
2. Plan for each building floor and the roof, showing the following:
 - a. Room layouts with room identification and name.
 - b. Locations and identification of all monitored and controlled HVAC equipment and other equipment being monitored and controlled by DDC system.
 - c. Location and identification of each hardware point being controlled or monitored by DDC system.
3. Control schematic for each of following, including a graphic system schematic representation, similar to that indicated on Drawings, with point identification, set point and dynamic value indication, sequence of operation and controller wiring diagram.
4. Graphic display for each piece of equipment connected to DDC system through a data communications link. Include dynamic indication of all points associated with equipment.
5. DDC system network riser diagram that shows schematic layout for entire system including all networks and all controllers, operator workstations and other network devices.

E. Customizing Software:

1. Software to modify and tailor DDC system to specific and unique requirements of equipment installed, to programs implemented and to staffing and operational practices planned.
2. Online modification of DDC system configuration, program parameters, and database using menu selection and keyboard entry of data into preformatted display templates.
3. As a minimum, include the following modification capability:
 - a. Operator assignment shall include designation of operator passwords, access levels, point segregation and auto sign-off.

- b. System text addition and change capability shall include English or native language descriptors for points and access levels and action messages for alarms, run time and trouble condition.
 - c. Time and schedule change capability shall include time and date set, time and occupancy schedules, exception and holiday schedules and daylight savings time schedules.
 - d. Point related change capability shall include the following:
 - 1) System and point enable and disable.
 - 2) Run-time enable and disable.
 - 3) Assignment of points to calibration tables, lockout, and run time and to a fixed I/O value.
 - 4) Assignment of alarm and warning limits.
 - e. Application program change capability shall include the following:
 - 1) Enable and disable of software programs.
 - 2) Programming changes.
 - 3) Assignment of comfort limits, global points, time and event initiators, time and event schedules and enable and disable time and event programs.
4. Software shall allow operator to add points, or groups of points, to DDC system and to link them to energy optimization and management programs. Additions and modifications shall be online programmable using operator workstation, downloaded to other network devices and entered into their databases. After verification of point additions and associated program operation, database shall be uploaded and recorded on hard drive and disk for archived record.
5. Include high-level language programming software capability for implementation of custom DDC programs. Software shall include a compiler, linker, and up- and down-load capability.
6. Include a library of DDC algorithms, intrinsic control operators, arithmetic, logic and relational operators for implementation of control sequences. Also include, as a minimum, the following:
- a. Proportional control (P).
 - b. Proportional plus integral (PI).
 - c. Proportional plus integral plus derivative (PID).
 - d. Adaptive and intelligent self-learning control (optimal start).
 - 1) Algorithm shall monitor loop response to output corrections and adjust loop response characteristics according to time constant changes imposed.
 - 2) Algorithm shall operate in a continuous self-learning manner and shall retain in memory a stored record of system dynamics so that on system shut down and restart, learning process starts from where it left off.
7. Fully implemented intrinsic control operators including sequence, reversing, ratio, time delay, time of day, highest select AO, lowest select AO, analog controlled digital output, analog control AO, and digitally controlled AO.
8. Logic operators such as "And," "Or," "Not," and others that are part of a standard set available with a high-level language.

9. Arithmetic operators such as "Add," "Subtract," "Multiply," "Divide," and others that are part of a standard set available with a high-level language.
10. Relational operators such as "Equal To," "Not Equal To," "Less Than," "Greater Than," and others that are part of a standard set available with a high-level language.

F. Alarm Handling Software:

1. Include alarm handling software to report all alarm conditions monitored and transmitted through DDC controllers and other network devices.
2. Include first in, first out handling of alarms according to alarm priority ranking, with most critical alarms first, and with buffer storage in case of simultaneous and multiple alarms.
3. Alarm handling shall be active at all times to ensure that alarms are processed even if an operator is not currently signed on to DDC system.
4. Alarms display shall include the following:
 - a. Indication of alarm condition such as "Abnormal Off," "Hi Alarm," and "Low Alarm."
 - b. "Analog Value" or "Status" group and point identification with native language point descriptor such as "Space Temperature, Building 110, 2nd Floor, Room 212."
 - c. Discrete per point alarm action message, such as "Call Maintenance Dept. Ext-5561."
 - d. Include extended message capability to allow assignment and printing of extended action messages. Capability shall be operator programmable and assignable on a per point basis.
5. Alarms shall be directed to appropriate operator workstations, printers, and individual operators by privilege level and assignments.
6. Alarms shall be categorized and processed by class.
 - a. Class 1:
 - 1) Associated with fire, security and other extremely critical equipment monitoring functions; have alarm, trouble, return to normal, and acknowledge conditions printed and displayed.
 - 2) Unacknowledged alarms to be placed in unacknowledged alarm buffer.
 - 3) All conditions shall cause an audible sound and shall require individual acknowledgment to silence audible sound.
 - b. Class 2:
 - 1) Critical, but not life-safety related, and processed same as Class 1 alarms, except do not require individual acknowledgment.
 - 2) Acknowledgement may be through a multiple alarm acknowledgment.
 - c. Class 3:
 - 1) General alarms; printed, displayed and placed in unacknowledged alarm buffer queues.

- 2) Acknowledgement of queued alarms shall be either on an individual basis or through a multiple alarm acknowledgement.
 - 3) Alarms returning to normal condition shall be printed and not cause an audible sound or require acknowledgment.
- d. Class 4:
- 1) Routine maintenance or other types of warning alarms.
 - 2) Alarms to be printed only, with no display, no audible sound and no acknowledgment required.
7. Include an unacknowledged alarm indicator on display to alert operator that there are unacknowledged alarms in system. Operator shall be able to acknowledge alarms on an individual basis or through a multiple alarm acknowledge key, depending on alarm class.
8. To ensure that no alarm records are lost, it shall be possible to assign a backup printer to accept alarms in case of failure of primary printer.
- G. Reports and Logs:
1. Include reporting software package that allows operator to select, modify, or create reports using DDC system I/O point data available.
 2. Each report shall be definable as to data content, format, interval and date.
 3. Report data shall be sampled and stored on DDC controller, within storage limits of DDC controller, and then uploaded to archive on workstation for historical reporting.
 4. Operator shall be able to obtain real-time logs of all I/O points by type or status, such as alarm, point lockout, or normal.
 5. Reports and logs shall be stored on workstation hard drives in a format that is readily accessible by other standard software applications, including spreadsheets and word processing.
 6. Reports and logs shall be readily printed and set to be printed either on operator command or at a specific time each day.
- H. Standard Reports: Standard DDC system reports shall be provided and operator shall be able to customize reports later.
1. All I/O: With current status and values.
 2. Alarm: All current alarms, except those in alarm lockout.
 3. Disabled I/O: All I/O points that are disabled.
 4. Alarm Lockout I/O: All I/O points in alarm lockout, whether manual or automatic.
 5. Alarm Lockout I/O in Alarm: All I/O in alarm lockout that are currently in alarm.
 6. Logs:
 - a. Alarm history.
 - b. System messages.
 - c. System events.
 - d. Trends.
- I. Custom Reports: Operator shall be able to easily define any system data into a daily, weekly, monthly, or annual report. Reports shall be time and date stamped and shall contain a report title.

- J. Utility Reports: Prepare Project-specific reports.
1. Electric Report:
 - a. Include weekly report showing daily electrical consumption and peak electrical demand with time and date stamp for each meter.
 - b. Include monthly report showing the daily electrical consumption and peak electrical demand with time and date stamp for each meter.
 - c. Include annual report showing the monthly electrical consumption and peak electrical demand with time and date stamp for each meter.
 - d. For each weekly, monthly and annual report, include sum total of submeters combined by load type, such as lighting, receptacles and HVAC equipment showing daily electrical consumption and peak electrical demand.
 - e. For each weekly, monthly and annual report, include sum total of all submeters in building showing electrical consumption and peak electrical demand.
 2. Natural Gas Report:
 - a. Include weekly report showing daily natural gas consumption and peak natural gas demand with time and date stamp for each meter.
 - b. Include monthly report showing the daily natural gas consumption and peak natural gas demand with time and date stamp for each meter.
 - c. Include annual report showing the monthly natural gas consumption and peak natural gas demand with time and date stamp for each meter.
 - d. For each weekly, monthly and annual report, include sum total of submeters combined by load type, such as boilers and service water heaters showing daily natural gas consumption and peak natural gas demand.
 - e. For each weekly, monthly and annual report, include sum total of all submeters in building showing natural gas consumption and peak natural gas demand.
- K. Energy Reports: Prepare Project-specific daily, weekly, monthly, annual and since-installed energy reports.
1. Prepare report for each purchased energy utility, indicating the following:
 - a. Time period being reported with beginning and end date, and time indicated.
 - b. Consumption in units of measure commonly used to report specific utility consumption over time.
 - c. Gross area served by utility.
 - d. Consumption per unit area served using utility-specific unit of measure.
 - e. Cost per utility unit.
 - f. Utility cost per unit area.
 - g. Convert all utilities to a common energy consumption unit of measure and report for each utility.
 - h. Consumption per unit area using common unit of measure.
- L. Standard Trends:
1. Trend all I/O point present values, set points, and other parameters indicated for trending.
 2. Trends shall be associated into groups, and a trend report shall be set up for each group.

3. Trends shall be stored within DDC controller and uploaded to hard drives automatically on reaching 75 percent of DDC controller buffer limit, or by operator request, or by archiving time schedule.
 4. Preset trend intervals for each I/O point after review with Owner.
 5. Trend intervals shall be operator selectable from 10 seconds up to 60 minutes. Minimum number of consecutive trend values stored at one time shall be 100 per variable.
 6. When drive storage memory is full, most recent data shall overwrite oldest data.
 7. Archived and real-time trend data shall be available for viewing numerically and graphically by operators.
- M. Custom Trends: Operator shall be able to define a custom trend log for any I/O point in DDC system.
1. Each trend shall include interval, start time, and stop time.
 2. Data shall be sampled and stored on DDC controller, within storage limits of DDC controller, and then uploaded to archive on workstation hard drives.
 3. Data shall be retrievable for use in spreadsheets and standard database programs.
- N. Programming Software:
1. Include programming software to execute sequences of operation indicated.
 2. Include programming routines in simple and easy to follow logic with detailed text comments describing what the logic does and how it corresponds to sequence of operation.
 3. Include means for detecting programming errors and testing software control strategies with a simulation tool before implementing in actual control. Simulation tool may be inherent with programming software or as a separate product.

2.11 OFFICE APPLICATION SOFTWARE

- A. Include current version of office application software at time of Substantial Completion.
- B. Office application software package shall include multiple separate applications and use a common platform for all applications, similar to Microsoft's "Office Professional."
1. Database.
 2. E-mail.
 3. Presentation.
 4. Publisher.
 5. Spreadsheet.
 6. Word processing.

2.12 ASHRAE 135 GATEWAYS

- A. Include BACnet communication ports, whenever available as an equipment OEM standard option, for integration via a single communication cable. BACnet-controlled plant equipment includes, but is not limited to, boilers, and variable-speed drives.

2.13 DDC CONTROLLERS

- A. DDC system shall consist of a combination of network controllers, programmable application controllers and application-specific controllers to satisfy performance requirements indicated.
- B. DDC controllers shall perform monitoring, control, energy optimization and other requirements indicated.
- C. DDC controllers shall use a multitasking, multiuser, real-time digital control microprocessor with a distributed network database and intelligence.
- D. Each DDC controller shall be capable of full and complete operation as a completely independent unit and as a part of a DDC system wide distributed network.
- E. Environment Requirements:
 - 1. Controller hardware shall be suitable for the anticipated ambient conditions.
- F. Power and Noise Immunity:
 - 1. Controller shall operate at 90 to 110 percent of nominal voltage rating and shall perform an orderly shutdown below 80 percent of nominal voltage.
 - 2. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios with up to 5 W of power located within 36 inches of enclosure.
- G. DDC Controller Spare Processing Capacity:
 - 1. Include spare processing memory for each controller. RAM, PROM, or EEPROM will implement requirements indicated with the following spare memory:
 - a. Network Controllers: 50 percent.
 - b. Programmable Application Controllers: Not less than 60 percent.
 - c. Application-Specific Controllers: Not less than 70 percent.
 - 2. Memory shall support DDC controller's operating system and database and shall include the following:
 - a. Monitoring and control.
 - b. Energy management, operation and optimization applications.
 - c. Alarm management.
 - d. Historical trend data of all connected I/O points.
 - e. Operator interfaces.
 - f. Monitoring of manual overrides.
- H. DDC Controller Spare I/O Point Capacity: Include spare I/O point capacity for each controller as follows:
 - 1. Network Controllers:
 - a. 10 percent of each AI, AO, BI, and BO point connected to controller.

- b. Minimum Spare I/O Points per Controller:
 - 1) AIs: Two.
 - 2) AOs: Two.
 - 3) BIs: Three.
 - 4) BOs: Three.
- 2. Programmable Application Controllers:
 - a. 10 percent of each AI, AO, BI, and BO point connected to controller.
 - b. Minimum Spare I/O Points per Controller:
 - 1) AIs: Three.
 - 2) AOs: Three.
 - 3) BIs: Three.
 - 4) BOs: Three.
- 3. Application-Specific Controllers:
 - a. 10 percent of each AI, AO, BI, and BO point connected to controller.
 - b. Minimum Spare I/O Points per Controller:
 - 1) AIs: One.
 - 2) AOs: One.
 - 3) BIs: One.
 - 4) BOs: One.
- I. Maintenance and Support: Include the following features to facilitate maintenance and support:
 - 1. Mount microprocessor components on circuit cards for ease of removal and replacement.
 - 2. Means to quickly and easily disconnect controller from network.
 - 3. Means to quickly and easily access connect to field test equipment.
 - 4. Visual indication that controller electric power is on, of communication fault or trouble, and that controller is receiving and sending signals to network.
- J. Input and Output Point Interface:
 - 1. Hardwired input and output points shall connect to network, programmable application and application-specific controllers.
 - 2. Input and output points shall be protected so shorting of point to itself, to another point, or to ground will not damage controller.
 - 3. Input and output points shall be protected from voltage up to 24 V of any duration so that contact will not damage controller.
 - 4. AIs:
 - a. AIs shall include monitoring of low-voltage (zero- to 10-V dc), current (4 to 20 mA) and resistance signals from thermistor and RTD sensors.
 - b. AIs shall be compatible with, and field configurable to, sensor and transmitters installed.

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- c. Controller AIs shall perform analog-to-digital (A-to-D) conversion with a minimum resolution of 12 bits or better to comply with accuracy requirements indicated.
 - d. Signal conditioning including transient rejection shall be provided for each AI.
 - e. Capable of being individually calibrated for zero and span.
 - f. Incorporate common-mode noise rejection of at least 50 dB from zero to 100 Hz for differential inputs, and normal-mode noise rejection of at least 20 dB at 60 Hz from a source impedance of 10000 ohms.
5. AOs:
- a. Controller AOs shall perform analog-to-digital (A-to-D) conversion with a minimum resolution of 12 bits or better to comply with accuracy requirements indicated.
 - b. Output signals shall have a range of 4 to 20 mA dc or zero- to 10-V dc as required to include proper control of output device.
 - c. Capable of being individually calibrated for zero and span.
 - d. AOs shall not exhibit a drift of greater than 0.4 percent of range per year.
 - e. Network and programmable application controller AOs shall be equipped with individual H-O-A switches and output adjustment potentiometers for use in the hand position.
6. BIs:
- a. Controller BIs shall accept contact closures and shall ignore transients of less than 5-ms duration.
 - b. Isolation and protection against an applied steady-state voltage of up to 180-V ac peak.
 - c. BIs shall include a wetting current of at least 12 mA to be compatible with commonly available control devices and shall be protected against effects of contact bounce and noise.
 - d. BIs shall sense "dry contact" closure without external power (other than that provided by the controller) being applied.
 - e. Pulse accumulation input points shall comply with all requirements of BIs and accept up to 10 pulses per second for pulse accumulation. Buffer shall be provided to totalize pulses. Pulse accumulator shall accept rates of at least 20 pulses per second. The totalized value shall be reset to zero on operator's command.
7. BOs:
- a. Controller BOs shall include relay contact closures or triac outputs for momentary and maintained operation of output devices.
 - 1) Relay contact closures shall have a minimum duration of 0.1 second. Relays shall include at least 180 V of isolation. Electromagnetic interference suppression shall be provided on all output lines to limit transients to non-damaging levels. Minimum contact rating shall be 1 A at 24-V ac.
 - 2) Triac outputs shall include at least 180 V of isolation. Minimum contact rating shall be 1 A at 24-V ac.

- b. BOs shall include for two-state operation or a pulsed low-voltage signal for pulse-width modulation control.
- c. BOs shall be selectable for either normally open or normally closed operation.
- d. Include tristate outputs (two coordinated BOs) for control of three-point floating-type electronic actuators without feedback.
- e. Limit use of three-point floating devices to VAV terminal unit control applications. Control algorithms shall operate actuator to one end of its stroke once every 24 hours for verification of operator tracking.

2.14 NETWORK CONTROLLERS

A. General Network Controller Requirements:

1. Include adequate number of controllers to achieve performance indicated.
2. System shall consist of one or more independent, standalone, microprocessor-based network controllers to manage global strategies indicated.
3. Controller shall have enough memory to support its operating system, database, and programming requirements.
4. Data shall be shared between networked controllers and other network devices.
5. Operating system of controller shall manage input and output communication signals to allow distributed controllers to share real and virtual object information and allow for central monitoring and alarms.
6. Controllers shall have a real-time clock.
7. Controller shall continually check status of its processor and memory circuits. If an abnormal operation is detected, controller shall assume a predetermined failure mode and generate an alarm notification.
8. Controllers shall be fully programmable.

B. Communication:

1. Network controllers shall communicate with other devices on DDC system Level one network.
2. Network controller also shall perform routing if connected to a network of programmable application and application-specific controllers.

C. Operator Interface:

1. Controller shall be equipped with a service communications port for connection to a portable operator's workstation or mobile device.

D. Serviceability:

1. Controller shall be equipped with diagnostic LEDs or other form of local visual indication of power, communication, and processor.
2. Wiring and cable connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
3. Controller shall maintain BIOS and programming information in event of a power loss for at least 96 hours.

2.15 PROGRAMMABLE APPLICATION CONTROLLERS

A. General Programmable Application Controller Requirements:

1. Include adequate number of controllers to achieve performance indicated.
2. Controller shall have enough memory to support its operating system, database, and programming requirements.
3. Data shall be shared between networked controllers and other network devices.
4. Operating system of controller shall manage input and output communication signals to allow distributed controllers to share real and virtual object information and allow for central monitoring and alarms.
5. Controllers shall have a real-time clock.
6. Controller shall continually check status of its processor and memory circuits. If an abnormal operation is detected, controller shall assume a predetermined failure mode and generate an alarm notification.
7. Controllers shall be fully programmable.

B. Communication:

1. Programmable application controllers shall communicate with other devices on network.

C. Operator Interface:

1. Controller shall be equipped with a service communications port for connection to a portable operator's workstation or mobile device.

D. Serviceability:

1. Controller shall be equipped with diagnostic LEDs or other form of local visual indication of power, communication, and processor.
2. Wiring and cable connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
3. Controller shall maintain BIOS and programming information in event of a power loss for at least 72 hours.

2.16 APPLICATION-SPECIFIC CONTROLLERS

A. Description: Microprocessor-based controllers, which through hardware or firmware design are dedicated to control a specific piece of equipment. Controllers are not fully user-programmable but are configurable and customizable for operation of equipment they are designed to control.

1. Capable of standalone operation and shall continue to include control functions without being connected to network.
2. Data shall be shared between networked controllers and other network devices.

B. Communication: Application-specific controllers shall communicate with other application-specific controller and devices on network, and to programmable application and network controllers.

- C. Operator Interface: Controller shall be equipped with a service communications port for connection to a portable operator's workstation. Connection shall extend to port on space temperature sensor that is connected to controller.
- D. Serviceability:
 - 1. Controller shall be equipped with diagnostic LEDs or other form of local visual indication of power, communication, and processor.
 - 2. Wiring and cable connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
 - 3. Controller shall use nonvolatile memory and maintain all BIOS and programming information in event of power loss.

2.17 CONTROLLER SOFTWARE

- A. General Controller Software Requirements:
 - 1. Software applications shall reside and operate in controllers. Editing of applications shall occur at operator workstations.
 - 2. I/O points shall be identified by up to 30-character point name and up to 16-character point descriptor. Same names shall be used at operator workstations.
 - 3. Control functions shall be executed within controllers using DDC algorithms.
 - 4. Controllers shall be configured to use stored default values to ensure fail-safe operation. Default values shall be used when there is a failure of a connected input instrument or loss of communication of a global point value.
- B. Security:
 - 1. Operator access shall be secured using individual security passwords and user names.
 - 2. Passwords shall restrict operator to points, applications, and system functions as assigned by system manager.
 - 3. Operator log-on and log-off attempts shall be recorded.
 - 4. System shall protect itself from unauthorized use by automatically logging off after last keystroke. The delay time shall be operator-definable.
- C. Scheduling: Include capability to schedule each point or group of points in system. Each schedule shall consist of the following:
 - 1. Weekly Schedule:
 - a. Include separate schedules for each day of week.
 - b. Each schedule should include the capability for start, stop, optimal start, optimal stop, and night economizer.
 - c. Each schedule may consist of up to 10 events.
 - d. When a group of objects are scheduled together, include capability to adjust start and stop times for each member.
 - 2. Exception Schedules:

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- a. Include ability for operator to designate any day of the year as an exception schedule.
 - b. Exception schedules may be defined up to a year in advance. Once an exception schedule is executed, it will be discarded and replaced by regular schedule for that day of week.
3. Holiday Schedules:
- a. Include capability for operator to define up to 99 special or holiday schedules.
 - b. Schedules may be placed on scheduling calendar and will be repeated each year.
 - c. Operator shall be able to define length of each holiday period.
- D. System Coordination:
1. Include standard application for proper coordination of equipment.
 2. Application shall include operator with a method of grouping together equipment based on function and location.
 3. Group may then be used for scheduling and other applications.
- E. Binary Alarms:
1. Each binary point shall be set to alarm based on operator-specified state.
 2. Include capability to automatically and manually disable alarming.
- F. Analog Alarms:
1. Each analog object shall have both high and low alarm limits.
 2. Alarming shall be able to be automatically and manually disabled.
- G. Alarm Reporting:
1. Operator shall be able to determine action to be taken in event of an alarm.
 2. Alarms shall be routed to appropriate operator workstations based on time and other conditions.
 3. Alarm shall be able to start programs, print, be logged in event log, generate custom messages, and display graphics.
- H. Remote Communication:
1. System shall have ability to dial out in the event of an alarm.
- I. Electric Power Demand Limiting:
1. Demand-limiting program shall monitor building or other operator-defined electric power consumption from signals connected to electric power meter or from a watt transducer or current transformer.
 2. Include the following information and reports, to be available on an hourly, daily, weekly, monthly and annual basis:
 - a. Total electric consumption.

- b. Peak demand.
 - c. Date and time of peak demand.
 - d. Daily peak demand.
- J. Maintenance Management: System shall monitor equipment status and generate maintenance messages based on operator-designated run-time, starts, and calendar date limits.
- K. Sequencing: Include application software based on sequences of operation indicated to properly sequence chillers, boilers, and other applicable HVAC equipment.
- L. Control Loops:
- 1. Support any of the following control loops, as applicable to control required:
 - a. Two-position (on/off, open/close, slow/fast) control.
 - b. Proportional control.
 - c. Proportional plus integral (PI) control.
 - d. Proportional plus integral plus derivative (PID) control.
 - 1) Include PID algorithms with direct or reverse action and anti-windup.
 - 2) Algorithm shall calculate a time-varying analog value used to position an output or stage a series of outputs.
 - 3) Controlled variable, set point, and PID gains shall be operator-selectable.
 - e. Adaptive (automatic tuning).
- M. Staggered Start: Application shall prevent all controlled equipment from simultaneously restarting after a power outage. Order which equipment (or groups of equipment) is started, along with the time delay between starts, shall be operator-selectable.
- N. Energy Calculations:
- 1. Include software to allow instantaneous power or flow rates to be accumulated and converted to energy usage data.
 - 2. Include an algorithm that calculates a sliding-window average (rolling average). Algorithm shall be flexible to allow window intervals to be operator specified (such as 15, 30, or 60 minutes).
 - 3. Include an algorithm that calculates a fixed-window average. A digital input signal shall define start of window period (such as signal from utility meter) to synchronize fixed-window average with that used by utility.
- O. Anti-Short Cycling:
- 1. BO points shall be protected from short cycling.
 - 2. Feature shall allow minimum on-time and off-time to be selected.
- P. On and Off Control with Differential:
- 1. Include an algorithm that allows a BO to be cycled based on a controlled variable and set point.

2. Algorithm shall be direct- or reverse-acting and incorporate an adjustable differential.

Q. Run-Time Totalization:

1. Include software to totalize run-times for all BI and BO points.
2. A high run-time alarm shall be assigned, if required, by operator.

2.18 ENCLOSURES

A. General Enclosure Requirements:

1. House each controller and associated control accessories in an enclosure. Enclosure shall serve as central tie-in point for control devices such as switches, transmitters, transducers, power supplies and transformers.
2. Do not house more than one controller in a single enclosure.
3. Include enclosure door with key locking mechanism. Key locks alike for all enclosures and include one pair of keys per enclosure.
4. Include wall-mounted enclosures with brackets suitable for mounting enclosures to wall or freestanding support stand as required.
5. Supply each enclosure with a complete set of as-built schematics and wiring diagrams and product literature located in a pocket on inside of door.

B. Internal Arrangement:

1. Internal layout of enclosure shall group and protect electric, and electronic components associated with a controller, but not an integral part of controller.
2. Arrange layout to group similar products together.
3. Include a barrier between line-voltage and low-voltage electrical and electronic products.
4. Factory or shop install products, tubing, cabling and wiring complying with requirements and standards indicated.
5. Terminate field cable and wire using heavy-duty terminal blocks.
6. Include spare terminals, equal to not less than 10 percent of used terminals.
7. Include spade lugs for stranded cable and wire.
8. Install a maximum of two wires on each side of a terminal.
9. Include enclosure field power supply with a toggle-type switch located at entrance inside enclosure to disconnect power.
10. Include enclosure with a line-voltage nominal 20-A GFCI duplex receptacle for service and testing tools. Wire receptacle on hot side of enclosure disconnect switch and include with a 5-A circuit breaker.
11. Mount products within enclosure on removable internal panel(s).
12. Include products mounted in enclosures with engraved, laminated phenolic nameplates (black letters on a white background). The nameplates shall have at least 1/4-inch- high lettering.
13. Route cable and wire located inside enclosure within a raceway with a continuous removable cover.
14. Label each end of cable and wire in enclosure following an approved identification system that extends from field I/O connection and all intermediate connections throughout length to controller connection.
15. Size enclosure internal panel to include at least 25 percent spare area on face of panel.

C. Environmental Requirements:

1. Evaluate temperature and humidity requirements of each product to be installed within each enclosure.
2. Where required by application, include temperature-controlled electrical heat to maintain inside of enclosure above minimum operating temperature of product with most stringent requirement.

2.19 RELAYS

A. General-Purpose Relays:

1. Relays shall be heavy duty and rated for at least 10 A at 250-V ac and 60 Hz.
2. Relays shall be either double pole double throw (DPDT) or three-pole double throw, depending on the control application.
3. Relays shall have LED indication.
4. Performance:
 - a. Mechanical Life: At least 10 million cycles.
 - b. Electrical Life: At least 100,000 cycles at rated load.
 - c. Pickup Time: 15 ms or less.
 - d. Dropout Time: 10 ms or less.
 - e. Pull-in Voltage: 85 percent of rated voltage.
 - f. Dropout Voltage: 50 percent of nominal rated voltage.
 - g. Power Consumption: 2 VA.
 - h. Ambient Operating Temperatures: Minus 40 to 115 deg F.
5. Equip relays with coil transient suppression to limit transients to non-damaging levels.

B. Current Sensing Relay:

1. Monitors ac current.
2. Independent adjustable controls for pickup and dropout current.
3. Energized when supply voltage is present and current is above pickup setting.
4. De-energizes when monitored current is below dropout current.
5. Dropout current is adjustable from 50 to 95 percent of pickup current.
6. Include a current transformer, if required for application.
7. House current sensing relay and current transformer in its own enclosure. Use NEMA 250, Type 12 enclosure for indoors and NEMA 250, Type 4 for outdoors.

2.20 ELECTRICAL POWER DEVICES

A. Transformers:

1. Transformer shall be sized for the total connected load, plus an additional 25 percent of connected load.
2. Transformer shall be at least 40 VA.
3. Transformer shall have both primary and secondary fuses.

B. Power-Line Conditioner:

1. General Power-Line Conditioner Requirements:
 - a. Design to ensure maximum reliability, serviceability and performance.
 - b. Overall function of the power-line conditioner is to receive raw, polluted electrical power and purify it for use by electronic equipment. The power-line conditioner shall provide isolated, regulated, transient and noise-free sinusoidal power to loads served.
2. Standards: NRTL listed per UL 1012.

2.21 UNINTERRUPTABLE POWER SUPPLY (UPS) UNITS FOR WORKSTATIONS

A. 250 through 1000 VA:

1. UPS units shall provide continuous, regulated output power without using their batteries during brown-out, surge, and spike conditions.
2. Load served shall not exceed 75 percent of UPS rated capacity, including power factor of connected loads.
 - a. Larger-capacity units shall be provided for systems with larger connected loads.
 - b. UPS shall provide five minutes of battery power.
3. Performance:
 - a. Input Voltage: Single phase, 120- or 230-V ac, compatible with field power source.
 - b. Load Power Factor Range (Crest Factor): 0.65 to 1.0.
 - c. Output Voltage: 101- to 132-V ac, while input voltage varies between 89 and 152-V ac.
 - d. On Battery Output Voltage: Sine wave.
 - e. Inverter overload capacity shall be minimum 150 percent for 30 seconds.
 - f. Recharge time shall be a maximum of six hours to 90 percent capacity after full discharge to cutoff.
 - g. Transfer Time: 6 ms.
 - h. Surge Voltage Withstand Capacity: IEEE C62.41, Categories A and B; 6 kV/200 and 500 A; 100-kHz ringwave.
4. UPS shall be automatic during fault or overload conditions.
5. Unit with integral line-interactive, power condition topology to eliminate all power contaminants.
6. Include front panel with power switch and visual indication of power, battery, fault and temperature.
7. Unit shall include an audible alarm of faults and front panel silence feature.
8. Unit with four NEMA WD 1, NEMA WD 6 Configuration 5-15R receptacles.
9. Batteries shall be sealed lead-acid type and be maintenance free. Battery replacement shall be front accessible by user without dropping load.

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10. Include tower models installed in ventilated cabinets to the particular installation location.

B. 1000 through 3000 VA:

1. UPS units shall provide continuous, regulated output power without using their batteries during brown-out, surge, and spike conditions.
2. Load served shall not exceed 75 percent of UPS rated capacity, including power factor of connected loads.
 - a. Larger-capacity units, or multiple units, shall be provided for systems with larger connected loads.
 - b. UPS shall provide five minutes of battery power.
3. Performance:
 - a. Input Voltage: Single phase, 120-V ac, plus 20 to minus 30 percent.
 - b. Power Factor: Minimum 0.97 at full load.
 - c. Output Voltage: Single phase, 120-V ac, within 3 percent, steady state with rated output current of 10.0 A, 30.0-A peak.
 - d. Inverter overload capacity shall be minimum 150 percent for 30 seconds.
 - e. Recharge time shall be a maximum of eight hours to 90 percent capacity.
4. UPS bypass shall be automatic during fault or overload conditions.
5. UPS shall include dry contacts (digital output points) for low battery condition and battery-on (primary utility power failure).
6. Batteries shall be sealed lead-acid type and be maintenance free.
7. Include tower models installed in ventilated cabinets or rack models installed on matching racks, as applicable to the particular installation location and space availability/configuration.

2.22 CONTROL WIRE AND CABLE

A. Wire: Single conductor control wiring above 24 V.

1. Wire size shall be at least No. 18 AWG.
2. Conductor shall be 7/24 soft annealed copper strand with 2- to 2.5-inch lay.
3. Conductor insulation shall be 600 V, Type THWN or Type THHN, and 90 deg C according to UL 83.
4. Conductor colors shall be black (hot), white (neutral), and green (ground).
5. Furnish wire on spools.

B. Single Twisted Shielded Instrumentation Cable above 24 V:

1. Wire size shall be a minimum No. 10 AWG.
2. Conductors shall be a twisted, 7/24 soft annealed copper strand with a 2- to 2.5-inch lay.
3. Conductor insulation shall have a Type THHN/THWN or Type TFN rating.
4. Shielding shall be 100 percent type, 0.35/0.5-mil aluminum/Mylar tape, helically applied with 25 percent overlap, and aluminum side in with tinned copper drain wire.

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5. Outer jacket insulation shall have a 600-V, 90-deg C rating and shall be Type TC cable.
6. For twisted pair, conductor colors shall be black and white. For twisted triad, conductor colors shall be black, red and white.
7. Furnish wire on spools.

C. Single Twisted Shielded Instrumentation Cable 24 V and Less:

1. Wire size shall be a minimum No. 20 AWG.
2. Conductors shall be a twisted, 7/24 soft annealed copper stranding with a 2- to 2.5-inch lay.
3. Conductor insulation shall have a nominal 15-mil thickness, constructed from flame-retardant PVC.
4. Shielding shall be 100 percent type, 1.35-mil aluminum/polymer tape, helically applied with 25 percent overlap, and aluminum side in with tinned copper drain wire.
5. Outer jacket insulation shall have a 300-V, 105-deg C rating and shall be Type PLTC cable.
6. For twisted pair, conductor colors shall be black and white. For twisted triad, conductor colors shall be black, red and white.
7. Furnish wire on spools.

D. LAN and Communication Cable: Comply with DDC system manufacturer requirements for network being installed.

1. Cable shall be balanced twisted pair.
2. Comply with the following requirements and for balanced twisted pair cable described in Section 260523 "Control-Voltage Electrical Power Cables" and Section 271513 "Communications Copper Horizontal Cabling."
 - a. Cable shall be plenum rated.
 - b. Cable shall have a unique color that is different from other cables used on Project.

2.23 RACEWAYS

- A. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for electrical power raceways and boxes.
- B. Comply with requirements in Section 270528 "Pathways for Communications Systems" for raceways for balanced twisted pair cables and optical fiber cables.

2.24 ACCESSORIES

A. Damper Blade Limit Switches:

1. Sense positive open and/or closed position of the damper blades.
2. NEMA 250, Type 13, oil-tight construction.
3. Arrange for the mounting application.
4. Additional waterproof enclosure when required by its environment.
5. Arrange to prevent "over-center" operation.

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B. Manual Valves:

1. Needle Type:

- a. PTFE packing.
- b. Construct of brass for use with copper and polyethylene tubing and of stainless steel for use with stainless-steel tubing.
- c. Aluminum T-bar handle.
- d. Include tubing connections.

2. Ball Type:

- a. Body: Bronze ASTM B 62 or ASTM B 61.
- b. Ball: Type 316 stainless steel.
- c. Stem: Type 316 stainless steel.
- d. Seats: Reinforced PTFE.
- e. Packing Ring: Reinforced PTFE.
- f. Lever: Stainless steel with a vinyl grip.
- g. 600 WOG.
- h. Threaded end connections.

C. Wall-Mounted Portable Workstation Cabinet:

1. Surface-mounted wall cabinet for tilt-out operation of laptop computers and large-format mobile devices.
2. Cabinet shall have a load limit of 50 lb.
3. Cabinet shall include the following:
 - a. Oil-filled dampers for controlled lowering of equipment to operational position.
 - b. 3RU EIA mounting rails.
 - c. Removable laptop shelf.
 - d. Separate top compartment with mounting area, hinged rail and security lock.
 - e. Front ventilation slots.
 - f. Knockouts for conduit connections on top and bottom of cabinet.
4. Cabinet shall be constructed of steel and painted with a powder-coat epoxy.
5. Inside center of backbox shall have provision to mount a field-furnished and -installed, single gang electrical outlet box.

2.25 IDENTIFICATION

A. Control Equipment, Instruments, and Control Devices:

1. Self-adhesive label bearing unique identification.
 - a. Include instruments with unique identification identified by equipment being controlled or monitored, followed by point identification.
2. Letter size shall be as follows:

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- a. Operator Workstations: Minimum of 0.5 inch high.
 - b. Printers: Minimum of 0.5 inch high.
 - c. DDC Controllers: Minimum of 0.5 inch high.
 - d. Repeaters: Minimum of 0.5 inch high.
 - e. Enclosures: Minimum of 0.5 inch high.
 - f. Electrical Power Devices: Minimum of 0.25 inch high.
 - g. UPS units: Minimum of 0.5 inch high.
 - h. Accessories: Minimum of 0.25 inch high.
 - i. Instruments: Minimum of 0.25 inch high.
 - j. Control Damper and Valve Actuators: Minimum of 0.25 inch high.
3. Legend shall consist of white lettering on black background.
 4. Instruments, control devices and actuators with Project-specific identification tags having unique identification numbers following requirements indicated and provided by original manufacturer do not require additional identification.
- B. Valve Tags:
1. Brass tags and brass chains attached to valve.
 2. Tags shall be at least 1.5 inches in diameter.
 3. Include tag with unique valve identification indicating control influence such as flow, level, pressure, or temperature; followed by location of valve, and followed by three-digit sequential number. For example: TV-1.001.
 4. Valves with Project-specific identification tags having unique identification numbers following requirements indicated and provided by original manufacturer do not require an additional tag.
- C. Raceway and Boxes:
1. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
 2. Paint cover plates on junction boxes and conduit same color as the tape banding for conduits. After painting, label cover plate "HVAC Controls," using an engraved phenolic tag.
- D. Equipment Warning Labels:
1. Self-adhesive label with pressure-sensitive adhesive back and peel-off protective jacket.
 2. Lettering size shall be at least 14-point type with white lettering on red background.
 3. Warning label shall read "CAUTION-Equipment operated under remote automatic control and may start or stop at any time without warning. Switch electric power disconnecting means to OFF position before servicing."
 4. Lettering shall be enclosed in a white line border. Edge of label shall extend at least 0.25 inch beyond white border.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
 - 1. Verify compatibility with and suitability of substrates.
- B. Examine roughing-in for products to verify actual locations of connections before installation.
 - 1. Examine roughing-in for instruments installed in piping to verify actual locations of connections before installation.
 - 2. Examine roughing-in for instruments installed in duct systems to verify actual locations of connections before installation.
- C. Examine walls, floors, roofs, and ceilings for suitable conditions where product will be installed.
- D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 DDC SYSTEM INTERFACE WITH OTHER SYSTEMS AND EQUIPMENT

- A. Communication Interface to Equipment with Integral Controls:
 - 1. DDC system shall have communication interface with equipment having integral controls and having a communication interface for remote monitoring or control.

3.3 CONTROL DEVICES FOR INSTALLATION BY INSTALLERS

- A. Deliver selected control devices, specified in indicated HVAC instrumentation and control device Sections, to identified equipment and systems manufacturers for factory installation and to identified installers for field installation.
- B. Deliver the following to duct fabricator and Installer for installation in ductwork. Include installation instructions to Installer and supervise installation for compliance with requirements.
 - 1. DDC control dampers, which are specified in Section 230923.12 "DDC Control Dampers."
 - 2. Airflow sensors and switches, which are specified in Section 230923.14 "Flow Instruments."
 - 3. Pressure sensors, which are specified in Section 230923.23 "Pressure Instruments."
- C. Deliver the following to plumbing and HVAC piping installers for installation in piping. Include installation instructions to Installer and supervise installation for compliance with requirements.

1. DDC control valves, which are specified in Section 230923.11 "Control Valves."
2. Pipe-mounted flow meters, which are specified in Section 230923.14 "Flow Instruments."
3. Pipe-mounted sensors, switches and transmitters. Flow meters are specified in Section 230923.14 "Flow Instruments." Liquid temperature sensors, switches, and transmitters are specified in Section 230923.27 "Temperature Instruments."
4. Pipe- and tank-mounted thermowells. Liquid thermowells are specified in Section 230923.27 "Temperature Instruments."

3.4 GENERAL INSTALLATION REQUIREMENTS

- A. Install products to satisfy more stringent of all requirements indicated.
- B. Install products level, plumb, parallel, and perpendicular with building construction.
- C. Support products, piping wiring, and raceways. Brace products to prevent lateral movement and sway or a break in attachment when subjected to a force.
- D. If codes and referenced standards are more stringent than requirements indicated, comply with requirements in codes and referenced standards.
- E. Fabricate openings and install sleeves in ceilings, floors, roof, and walls required by installation of products. Before proceeding with drilling, punching, and cutting, check for concealed work to avoid damage. Patch, flash, grout, seal, and refinish openings to match adjacent condition.
- F. Firestop Penetrations Made in Fire-Rated Assemblies: Comply with requirements in Section 078413 "Penetration Firestopping."
- G. Seal penetrations made in acoustically rated assemblies. Comply with requirements in Section 079219 "Acoustical Joint Sealants."
- H. Welding Requirements:
 1. Restrict welding and burning to supports and bracing.
 2. No equipment shall be cut or welded without approval. Welding or cutting will not be approved if there is risk of damage to adjacent Work.
 3. Welding, where approved, shall be by inert-gas electric arc process and shall be performed by qualified welders according to applicable welding codes.
 4. If requested on-site, show satisfactory evidence of welder certificates indicating ability to perform welding work intended.
- I. Fastening Hardware:
 1. Stillson wrenches, pliers, and other tools that damage surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening fasteners.
 2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
 3. Lubricate threads of bolts, nuts and screws with graphite and oil before assembly.

- J. If product locations are not indicated, install products in locations that are accessible and that will permit service and maintenance from floor, equipment platforms, or catwalks without removal of permanently installed furniture and equipment.

3.5 WORKSTATION INSTALLATION

A. Desktop Workstations Installation:

1. Install workstation(s) at location(s) directed by Owner.
2. Install multiple-receptacle power strip with cord for use in connecting multiple workstation components to a single duplex electrical power receptacle.
3. Install software on workstation(s) and verify software functions properly.
4. Develop Project-specific graphics, trends, reports, logs and historical database.
5. Power each workstation through a dedicated UPS unit. Locate UPS adjacent to workstation.

B. Portable Workstations Installation:

1. Turn over portable workstations to Owner at Substantial Completion.
2. Install software on workstation(s) and verify software functions properly.

C. Color Graphics Application:

1. Use system schematics indicated as starting point to create graphics.
2. Develop Project-specific library of symbols for representing system equipment and products.
3. Incorporate digital images of Project-completed installation into graphics where beneficial to enhance effect.
4. Submit sketch of graphic layout with description of all text for each graphic for Owner's and Architect's review before creating graphic using graphics software.
5. Seek Owner input in graphics development once using graphics software.
6. Final editing shall be done on-site with Owner's and Architect's review and feedback.
7. Refine graphics as necessary for Owner acceptance.
8. On receiving Owner acceptance, print a hard copy for inclusion in operation and maintenance manual. Prepare a scanned copy PDF file of each graphic and include with softcopy of DDC system operation and maintenance manual.

D. Wall-Mounted Portable Operator's Workstation Cabinet Installation:

1. Install wall-mounted portable operator's workstation cabinet(s) at location(s) indicated on Drawings.
2. Install wall-mounted portable operator's workstation cabinet(s) at following location(s) and at locations directed by Owner:
 - a. Each mechanical room.
 - b. Boiler room.

3.6 PRINTER INSTALLATION

- A. Provide the following printer(s) at location(s) directed by Owner:
 - 1. Color Inkjet: Quantity, one per desktop workstation.
- B. Install printer software on workstations and verify that software functions properly.

3.7 ROUTER INSTALLATION

- A. Install routers if required for DDC system communication interface requirements indicated.
 - 1. Install router(s) required to suit indicated requirements.
- B. Test router to verify that communication interface functions properly.

3.8 CONTROLLER INSTALLATION

- A. Install controllers in enclosures to comply with indicated requirements.
- B. Connect controllers to field power supply.
- C. Install controller with latest version of applicable software and configure to execute requirements indicated.
- D. Test and adjust controllers to verify operation of connected I/O to achieve performance indicated requirements while executing sequences of operation.
- E. Installation of Network Controllers:
 - 1. Quantity and location of network controllers shall be determined by DDC system manufacturer to satisfy requirements indicated.
 - 2. Install controllers in a protected location that is easily accessible by operators.
 - 3. Top of controller shall be within 84 inches of finished floor.
- F. Installation of Programmable Application Controllers:
 - 1. Quantity and location of programmable application controllers shall be determined by DDC system manufacturer to satisfy requirements indicated.
 - 2. Install controllers in a protected location that is easily accessible by operators.
 - 3. Top of controller shall be within 84 inches of finished floor.
- G. Application-Specific Controllers:
 - 1. Quantity and location of application-specific controllers shall be determined by DDC system manufacturer to satisfy requirements indicated.
 - 2. For controllers not mounted directly on equipment being controlled, install controllers in a protected location that is easily accessible by operators.

3.9 INSTALLATION OF WIRELESS ROUTERS FOR OPERATOR INTERFACE

- A. Install wireless routers to achieve optimum performance and best possible coverage.
- B. Mount wireless routers in a protected location that is within 60 inches of floor and easily accessible by operators.

3.10 ELECTRIC POWER CONNECTIONS

- A. Connect electrical power to DDC system products requiring electrical power connections.
- B. Design of electrical power to products not indicated with electric power is delegated to DDC system provider and installing trade. Work shall comply with NFPA 70 and other requirements indicated.
- C. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers" for electrical power circuit breakers.
- D. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for electrical power conductors and cables.
- E. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for electrical power raceways and boxes.

3.11 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements in Section 260553 "Identification for Electrical Systems" for identification products and installation.
- B. Install self-adhesive labels with unique identification on face for each of the following:
 - 1. Operator workstation.
 - 2. Printer.
 - 3. Router.
 - 4. DDC controller.
 - 5. Enclosure.
 - 6. Electrical power device.
 - 7. UPS unit.
 - 8. Accessory.
- C. Install unique instrument identification on face of each instrument connected to a DDC controller.
- D. Install unique identification on face of each control damper and valve actuator connected to a DDC controller.
- E. Warning Labels and Signs:

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1. Shall be permanently attached to equipment that can be automatically started by DDC control system.
2. Shall be located in highly visible location near power service entry points.

3.12 NETWORK INSTALLATION

A. Install cable in continuous raceway.

1. Where indicated on Drawings, cable trays may be used for copper cable in lieu of conduit.

3.13 NETWORK NAMING AND NUMBERING

A. Coordinate with Owner and provide unique naming and addressing for networks and devices.

B. ASHRAE 135 Networks:

1. MAC Address:

- a. Every network device shall have an assigned and documented MAC address unique to its network.
- b. Ethernet Networks: Document MAC address assigned at its creation.
- c. ARCNET or MS/TP networks: Assign from 00 to 64.

2. Network Numbering:

- a. Assign unique numbers to each new network.
- b. Provide ability for changing network number through device switches or operator interface.
- c. DDC system, with all possible connected LANs, can contain up to 65,534 unique networks.

3. Device Object Identifier Property Number:

- a. Assign unique device object identifier property numbers or device instances for each device network.
- b. Provide for future modification of device instance number by device switches or operator interface.
- c. LAN shall support up to 4,194,302 unique devices.

4. Device Object Name Property Text:

- a. Device object name property field shall support 32 minimum printable characters.
- b. Assign unique device "Object Name" property names with plain-English descriptive names for each device.

- 1) Example 1: Device object name for device controlling boiler plant at Building 1000 would be "HW System B1000."

- 2) Example 2: Device object name for a VAV terminal unit controller could be "VAV unit 102".
5. Object Name Property Text for Other Than Device Objects:
 - a. Object name property field shall support 32 minimum printable characters.
 - b. Assign object name properties with plain-English names descriptive of application.
 - 1) Example 1: "Zone 1 Temperature."
 - 2) Example 2 "Fan Start and Stop."
 6. Object Identifier Property Number for Other Than Device Objects:
 - a. Assign object identifier property numbers according to Drawings indicated.
 - b. If not indicated, object identifier property numbers may be assigned at Installer's discretion but must be approved by Owner in advance, be documented and be unique for like object types within device.

3.14 CONTROL WIRE, CABLE AND RACEWAYS INSTALLATION

A. Comply with NECA 1.

B. Wire and Cable Installation:

1. Comply with installation requirements in Section 260523 "Control-Voltage Electrical Power Cables."
2. Comply with installation requirements in Section 271313 "Communications Copper Backbone Cabling."
3. Comply with installation requirements in Section 271513 "Communications Copper Horizontal Cabling."
4. Install cables with protective sheathing that is waterproof and capable of withstanding continuous temperatures of 90 deg C with no measurable effect on physical and electrical properties of cable.
 - a. Provide shielding to prevent interference and distortion from adjacent cables and equipment.
5. Terminate wiring in a junction box.
 - a. Clamp cable over jacket in junction box.
 - b. Individual conductors in the stripped section of the cable shall be slack between the clamping point and terminal block.
6. Terminate field wiring and cable not directly connected to instruments and control devices having integral wiring terminals using terminal blocks.
7. Install signal transmission components according to IEEE C2, REA Form 511a, NFPA 70, and as indicated.
8. Use shielded cable to transmitters.
9. Use shielded cable to temperature sensors.

10. Perform continuity and meager testing on wire and cable after installation.

C. Conduit Installation:

1. Comply with Section "260533 "Raceways and Boxes for Electrical Systems" for control-voltage conductors.
2. Comply with Section 270528 "Pathways for Communications Systems" for balanced twisted pair cabling and optical fiber installation.

3.15 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and installations, including connections.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Testing:

1. Perform preinstallation, in-progress, and final tests, supplemented by additional tests, as necessary.
2. Preinstallation Cable Verification: Verify integrity and serviceability for new cable lengths before installation. This assurance may be provided by using vendor verification documents, testing, or other methods. As a minimum, furnish evidence of verification for cable attenuation and bandwidth parameters.
3. In-Progress Testing: Perform standard tests for correct pair identification and termination during installation to ensure proper installation and cable placement. Perform tests in addition to those specified if there is any reason to question condition of material furnished and installed. Testing accomplished is to be documented by agency conducting tests. Submit test results for Project record.
4. Final Testing: Perform final test of installed system to demonstrate acceptability as installed. Testing shall be performed according to a test plan supplied by DDC system manufacturer. Defective Work or material shall be corrected and retested. As a minimum, final testing for cable system, including spare cable, shall verify conformance of attenuation, length, and bandwidth parameters with performance indicated.
5. Test Results: Record test results and submit copy of test results for Project record.

3.16 DDC SYSTEM I/O CHECKOUT PROCEDURES

A. Check installed products before continuity tests, leak tests and calibration.

B. Check instruments for proper location and accessibility.

- C. Check instruments for proper installation on direction of flow, elevation, orientation, insertion depth, or other applicable considerations that will impact performance.
- D. Control Damper Checkout:
 - 1. Verify that control dampers are installed correctly for flow direction.
 - 2. Verify that proper blade alignment, either parallel or opposed, has been provided.
 - 3. Verify that damper frame attachment is properly secured and sealed.
 - 4. Verify that damper actuator and linkage attachment is secure.
 - 5. Verify that actuator wiring is complete, enclosed and connected to correct power source.
 - 6. Verify that damper blade travel is unobstructed.
- E. Control Valve Checkout:
 - 1. Verify that control valves are installed correctly for flow direction.
 - 2. Verify that valve body attachment is properly secured and sealed.
 - 3. Verify that valve actuator and linkage attachment is secure.
 - 4. Verify that actuator wiring is complete, enclosed and connected to correct power source.
 - 5. Verify that valve ball, disc or plug travel is unobstructed.
 - 6. After piping systems have been tested and put into service, but before insulating and balancing, inspect each valve for leaks. Adjust or replace packing to stop leaks. Replace the valve if leaks persist.
- F. Instrument Checkout:
 - 1. Verify that instrument is correctly installed for location, orientation, direction and operating clearances.
 - 2. Verify that attachment is properly secured and sealed.
 - 3. Verify that conduit connections are properly secured and sealed.
 - 4. Verify that wiring is properly labeled with unique identification, correct type and size and is securely attached to proper terminals.
 - 5. Inspect instrument tag against approved submittal.
 - 6. For instruments with tubing connections, verify that tubing attachment is secure and isolation valves have been provided.
 - 7. For flow instruments, verify that recommended upstream and downstream distances have been maintained.
 - 8. For temperature instruments:
 - a. Verify sensing element type and proper material.
 - b. Verify length and insertion.

3.17 DDC SYSTEM I/O ADJUSTMENT, CALIBRATION AND TESTING:

- A. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.
- B. Provide a written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.

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- C. For each analog instrument, make a three-point test of calibration for both linearity and accuracy.
- D. Equipment and procedures used for calibration shall comply with instrument manufacturer's written instructions.
- E. Provide diagnostic and test equipment for calibration and adjustment.
- F. Field instruments and equipment used to test and calibrate installed instruments shall have accuracy at least twice the instrument accuracy being calibrated. An installed instrument with an accuracy of 1 percent shall be checked by an instrument with an accuracy of 0.5 percent.
- G. Calibrate each instrument according to instrument instruction manual supplied by manufacturer.
- H. If after calibration indicated performance cannot be achieved, replace out-of-tolerance instruments.
- I. Comply with field testing requirements and procedures indicated by ASHRAE's Guideline 11, "Field Testing of HVAC Control Components," in the absence of specific requirements, and to supplement requirements indicated.
- J. Analog Signals:
 - 1. Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.
 - 2. Check analog current signals using a precision current meter at zero, 50, and 100 percent.
 - 3. Check resistance signals for temperature sensors at zero, 50, and 100 percent of operating span using a precision-resistant source.
- K. Digital Signals:
 - 1. Check digital signals using a jumper wire.
 - 2. Check digital signals using an ohmmeter to test for contact making or breaking.
- L. Control Dampers:
 - 1. Stroke and adjust control dampers following manufacturer's recommended procedure, from 100 percent open to 100 percent closed and back to 100 percent open.
 - 2. Check and document open and close cycle times for applications with a cycle time less than 30 seconds.
 - 3. For control dampers equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.
- M. Control Valves:
 - 1. Stroke and adjust control valves following manufacturer's recommended procedure, from 100 percent open to 100 percent closed and back to 100 percent open.
 - 2. Check and document open and close cycle times for applications with a cycle time less than 30 seconds.

3. For control valves equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

N. Meters: Check sensors at zero, 50, and 100 percent of Project design values.

O. Sensors: Check sensors at zero, 50, and 100 percent of Project design values.

P. Switches: Calibrate switches to make or break contact at set points indicated.

Q. Transmitters:

1. Check and calibrate transmitters at zero, 50, and 100 percent of Project design values.
2. Calibrate resistance temperature transmitters at zero, 50, and 100 percent of span using a precision-resistant source.

3.18 DDC SYSTEM CONTROLLER CHECKOUT

A. Verify power supply.

1. Verify voltage, phase and hertz.
2. Verify that protection from power surges is installed and functioning.
3. Verify that ground fault protection is installed.
4. If applicable, verify if connected to UPS unit.
5. If applicable, verify if connected to a backup power source.
6. If applicable, verify that power conditioning units, transient voltage suppression and high-frequency noise filter units are installed.

B. Verify that wire and cabling is properly secured to terminals and labeled with unique identification.

C. Verify that spare I/O capacity is provided.

3.19 DDC CONTROLLER I/O CONTROL LOOP TESTS

A. Testing:

1. Test every I/O point connected to DDC controller to verify that safety and operating control set points are as indicated and as required to operate controlled system safely and at optimum performance.
2. Test every I/O point throughout its full operating range.
3. Test every control loop to verify operation is stable and accurate.
4. Adjust control loop proportional, integral and derivative settings to achieve optimum performance while complying with performance requirements indicated. Document testing of each control loop's precision and stability via trend logs.
5. Test and adjust every control loop for proper operation according to sequence of operation.
6. Test software and hardware interlocks for proper operation. Correct deficiencies.
7. Operate each analog point at the following:

- a. Upper quarter of range.
 - b. Lower quarter of range.
 - c. At midpoint of range.
8. Exercise each binary point.
 9. For every I/O point in DDC system, read and record each value at operator workstation, at DDC controller and at field instrument simultaneously. Value displayed at operator workstation, at DDC controller and at field instrument shall match.
 10. Prepare and submit a report documenting results for each I/O point in DDC system and include in each I/O point a description of corrective measures and adjustments made to achieve desired results.

3.20 DDC SYSTEM VALIDATION TESTS

- A. Perform validation tests before requesting final review of system. Before beginning testing, first submit Pretest Checklist and Test Plan.
- B. After approval of Test Plan, execute all tests and procedures indicated in plan.
- C. After testing is complete, submit completed test checklist.
- D. Pretest Checklist: Submit the following list with items checked off once verified:
 1. Detailed explanation for any items that are not completed or verified.
 2. Required mechanical installation work is successfully completed and HVAC equipment is working correctly.
 3. HVAC equipment motors operate below full-load amperage ratings.
 4. Required DDC system components, wiring, and accessories are installed.
 5. Installed DDC system architecture matches approved Drawings.
 6. Control electric power circuits operate at proper voltage and are free from faults.
 7. Required surge protection is installed.
 8. DDC system network communications function properly, including uploading and downloading programming changes.
 9. Each controller's programming is backed up.
 10. Equipment, products, tubing, wiring cable and conduits are properly labeled.
 11. All I/O points are programmed into controllers.
 12. Testing, adjusting and balancing work affecting controls is complete.
 13. Dampers and actuators zero and span adjustments are set properly.
 14. Each control damper and actuator goes to failed position on loss of power.
 15. Valves and actuators zero and span adjustments are set properly.
 16. Each control valve and actuator goes to failed position on loss of power.
 17. Meter, sensor and transmitter readings are accurate and calibrated.
 18. Control loops are tuned for smooth and stable operation.
 19. View trend data where applicable.
 20. Each controller works properly in standalone mode.
 21. Safety controls and devices function properly.
 22. Interfaces with fire-alarm system function properly.
 23. Electrical interlocks function properly.

24. Operator workstations and other interfaces are delivered, all system and database software is installed, and graphic are created.
25. Record Drawings are completed.

E. Test Plan:

1. Prepare and submit a validation test plan including test procedures for performance validation tests.
2. Test plan shall address all specified functions of DDC system and sequences of operation.
3. Explain detailed actions and expected results to demonstrate compliance with requirements indicated.
4. Explain method for simulating necessary conditions of operation used to demonstrate performance.
5. Include a test checklist to be used to check and initial that each test has been successfully completed.
6. Submit test plan documentation 20 business days before start of tests.

F. Validation Test:

1. Verify operating performance of each I/O point in DDC system.
 - a. Verify analog I/O points at operating value.
 - b. Make adjustments to out-of-tolerance I/O points.
 - 1) Identify I/O points for future reference.
 - 2) Simulate abnormal conditions to demonstrate proper function of safety devices.
 - 3) Replace instruments and controllers that cannot maintain performance indicated after adjustments.
2. Simulate conditions to demonstrate proper sequence of control.
3. Readjust settings to design values and observe ability of DDC system to establish desired conditions.
4. After 24 Hours following Initial Validation Test:
 - a. Re-check I/O points that required corrections during initial test.
 - b. Identify I/O points that still require additional correction and make corrections necessary to achieve desired results.
5. After 24 Hours of Second Validation Test:
 - a. Re-check I/O points that required corrections during second test.
 - b. Continue validation testing until I/O point is normal on two consecutive tests.
6. Completely check out, calibrate, and test all connected hardware and software to ensure that DDC system performs according to requirements indicated.
7. After validation testing is complete, prepare and submit a report indicating all I/O points that required correction and how many validation re-tests it took to pass. Identify adjustments made for each test and indicate instruments that were replaced.

G. DDC System Response Time Test:

1. Simulate HLC.
 - a. Heavy load shall be an occurrence of 50 percent of total connected binary COV, one-half of which represent an "alarm" condition, and 50 percent of total connected analog COV, one-half of which represent an "alarm" condition, that are initiated simultaneously on a one-time basis.
2. Initiate 10 successive occurrences of HLC and measure response time to typical alarms and status changes.
3. Measure with a timer having at least 0.1-second resolution and 0.01 percent accuracy.
4. Purpose of test is to demonstrate DDC system, as follows:
 - a. Reaction to COV and alarm conditions during HLC.
 - b. Ability to update DDC system database during HLC.
5. Passing test is contingent on the following:
 - a. Alarm reporting at printer beginning no more than two seconds after the initiation (time zero) of HLC.
 - b. All alarms, both binary and analog, are reported and printed; none are lost.
 - c. Compliance with response times specified.
6. Prepare and submit a report documenting HLC tested and results of test including time stamp and print out of all alarms.

H. DDC System Network Bandwidth Test:

1. Test network bandwidth usage on all DDC system networks to demonstrate bandwidth usage under DDC system normal operating conditions and under simulated HLC.
2. To pass, none of DDC system networks shall use more than 70 percent of available bandwidth under normal and HLC operation.

3.21 FINAL REVIEW

- A. Submit written request to Architect and Owner when DDC system is ready for final review. Written request shall state the following:
1. DDC system has been thoroughly inspected for compliance with contract documents and found to be in full compliance.
 2. DDC system has been calibrated, adjusted and tested and found to comply with requirements of operational stability, accuracy, speed and other performance requirements indicated.
 3. DDC system monitoring and control of HVAC systems results in operation according to sequences of operation indicated.
 4. DDC system is complete and ready for final review.

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- B. Review by Architect and Owner shall be made after receipt of written request. A field report shall be issued to document observations and deficiencies.
- C. Take prompt action to remedy deficiencies indicated in field report and submit a second written request when all deficiencies have been corrected. Repeat process until no deficiencies are reported.
- D. Should more than two reviews be required, DDC system manufacturer and Installer shall compensate entity performing review for total costs, labor and expenses, associated with third and subsequent reviews. Estimated cost of each review shall be submitted and approved by DDC system manufacturer and Installer before making the review.
- E. Prepare and submit closeout submittals and begin procedures indicated in "Extended Operation Test" Article when no deficiencies are reported.
- F. A part of DDC system final review shall include a demonstration to parties participating in final review.
 - 1. Provide staff familiar with DDC system installed to demonstrate operation of DDC system during final review.
 - 2. Provide testing equipment to demonstrate accuracy and other performance requirements of DDC system that is requested by reviewers during final review.
 - 3. Demonstration shall include, but not be limited to, the following:
 - a. Accuracy and calibration of 10 I/O points randomly selected by reviewers. If review finds that some I/O points are not properly calibrated and not satisfying performance requirements indicated, additional I/O points may be selected by reviewers until total I/O points being reviewed that satisfy requirements equals quantity indicated.
 - b. HVAC equipment and system hardwired and software safeties and life-safety functions are operating according to sequence of operation. Up to 10 I/O points shall be randomly selected by reviewers. Additional I/O points may be selected by reviewers to discover problems with operation.
 - c. Correct sequence of operation after electrical power interruption and resumption after electrical power is restored for randomly selected HVAC systems.
 - d. Operation of randomly selected dampers and valves in normal-on, normal-off and failed positions.
 - e. Reporting of alarm conditions for randomly selected alarms, including different classes of alarms, to ensure that alarms are properly received by operators and operator workstations.
 - f. Trends, summaries, logs and reports set-up for Project.
 - g. For up to three HVAC systems randomly selected by reviewers, use graph trends to show that sequence of operation is executed in correct manner and that HVAC systems operate properly through complete sequence of operation including different modes of operations indicated. Show that control loops are stable and operating at set points and respond to changes in set point of 20 percent or more.
 - h. Software's ability to communicate with controllers, operator workstations, uploading and downloading of control programs.
 - i. Software's ability to edit control programs off-line.

- j. Data entry to show Project-specific customizing capability including parameter changes.
- k. Step through penetration tree, display all graphics, demonstrate dynamic update, and direct access to graphics.
- l. Execution of digital and analog commands in graphic mode.
- m. Spreadsheet and curve plot software and its integration with database.
- n. Multitasking by showing different operations occurring simultaneously on four quadrants of split screen.
- o. System speed of response compared to requirements indicated.
- p. For Each Network and Programmable Application Controller:
 - 1) Memory: Programmed data, parameters, trend and alarm history collected during normal operation is not lost during power failure.
 - 2) Operator Interface: Ability to connect directly to each type of digital controller with a portable workstation and mobile device. Show that maintenance personnel interface tools perform as indicated in manufacturer's technical literature.
 - 3) Standalone Ability: Demonstrate that controllers provide stable and reliable standalone operation using default values or other method for values normally read over network.
 - 4) Electric Power: Ability to disconnect any controller safely from its power source.
 - 5) Wiring Labels: Match control drawings.
 - 6) Network Communication: Ability to locate a controller's location on network and communication architecture matches Shop Drawings.
 - 7) Nameplates and Tags: Accurate and permanently attached to control panel doors, instrument, actuators and devices.
- q. For Each Operator Workstation:
 - 1) I/O points lists agree with naming conventions.
 - 2) Graphics are complete.
 - 3) UPS unit, if applicable, operates.
- r. Communications and Interoperability: Demonstrate proper interoperability of data sharing, alarm and event management, trending, scheduling, and device and network management. Use ASHRAE 135 protocol analyzer to help identify devices, view network traffic, and verify interoperability. Requirements must be met even if only one manufacturer's equipment is installed.
 - 1) Data Presentation: On each operator workstation, demonstrate graphic display capabilities.
 - 2) Reading of Any Property: Demonstrate ability to read and display any used readable object property of any device on network.
 - 3) Set Point and Parameter Modifications: Show ability to modify set points and tuning parameters indicated. Modifications are made with messages and write services initiated by an operator using workstation graphics, or by completing a field in a menu with instructional text.

- 4) Peer-to-Peer Data Exchange: Network devices are installed and configured to perform without need for operator intervention to implement Project sequence of operation and to share global data.
- 5) Alarm and Event Management: Alarms and events are installed and prioritized according to Owner. Demonstrate that time delays and other logic are set up to avoid nuisance tripping. Show that operators with sufficient privileges are permitted.
- 6) Schedule Lists: Schedules are configured for start and stop, mode change, occupant overrides, and night setback as defined in sequence of operations.
- 7) Schedule Display and Modification: Ability to display any schedule with start and stop times for calendar year. Show that all calendar entries and schedules are modifiable from any connected operator workstation by an operator with sufficient privilege.
- 8) Archival Storage of Data: Data archiving is handled by operator workstation and server and local trend archiving and display is accomplished.
- 9) Modification of Trend Log Object Parameters: Operator with sufficient privilege can change logged data points, sampling rate, and trend duration.
- 10) Device and Network Management:
 - a) Display of network device status.
 - b) Display of BACnet Object Information.
 - c) Silencing devices transmitting erroneous data.
 - d) Time synchronization.
 - e) Remote device re-initialization.
 - f) Backup and restore network device programming and master database(s).
 - g) Configuration management of routers.

3.22 EXTENDED OPERATION TEST

- A. Extended operation test is intended to simulate normal operation of DDC system by Owner.
- B. Operate DDC system for an operating period of 28 consecutive calendar days following Substantial Completion. Coordinate exact start date of testing with Owner.
- C. Provide an operator familiar with DDC system installed to man an operator workstation while on-site during eight hours of each normal business day occurring during operating period.
- D. During operating period, DDC system shall demonstrate correct operation and accuracy of monitored and controlled points as well as operation capabilities of sequences, logs, trends, reports, specialized control algorithms, diagnostics, and other software indicated.
 1. Correct defects of hardware and software when it occurs.
- E. Definition of Failures and Downtime during Operating Period:
 1. Failed I/O point constituting downtime is an I/O point failing to perform its intended function consistently and a point physically failed due to hardware and software.
 2. Downtime is when any I/O point in DDC system is unable to fulfill its' required function.

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3. Downtime shall be calculated as elapsed time between a detected point failure as confirmed by an operator and time point is restored to service.
 4. Maximum time interval allowed between DDC system detection of failure occurrence and operator confirmation shall be 0.5 hours.
 5. Downtime shall be logged in hours to nearest 0.1 hour.
 6. Power outages shall not count as downtime, but shall suspend test hours unless systems are provided with UPS and served through a backup power source.
 7. Hardware or software failures caused by power outages shall count as downtime.
- F. During operating period, log downtime and operational problems are encountered.
1. Identify source of problem.
 2. Provide written description of corrective action taken.
 3. Record duration of downtime.
 4. Maintain log showing the following:
 - a. Time of occurrence.
 - b. Description of each occurrence and pertinent written comments for reviewer to understand scope and extent of occurrence.
 - c. Downtime for each failed I/O point.
 - d. Running total of downtime and total time of I/O point after each problem has been restored.
 5. Log shall be available to Owner for review at any time.
- G. For DDC system to pass extended operation test, total downtime shall not exceed 2 percent of total point-hours during operating period.
1. Failure to comply with minimum requirements of passing at end of operating period indicated shall require that operating period be extended one consecutive day at a time until DDC system passes requirement.
- H. Evaluation of DDC system passing test shall be based on the following calculation:
1. Downtime shall be counted on a point-hour basis where total number of DDC system point-hours is equal to total number of I/O points in DDC system multiplied by total number of hours during operating period.
 2. One point-hour of downtime is one I/O point down for one hour. Three points down for five hours is a total of 15 point-hours of downtime. Four points down for one-half hour is 2 point-hours of downtime.
 3. Example Calculation: Maximum allowable downtime for 30-day test when DDC system has 1000 total I/O points (combined analog and binary) and has passing score of 1 percent downtime is computed by $30 \text{ days} \times 24 \text{ h/day} \times 1000 \text{ points} \times 1 \text{ percent}$ equals 7200 point-hours of maximum allowable downtime.
- I. Prepare test and inspection reports.

3.23 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months from 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.

3.24 MAINTENANCE SERVICE

- A. Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by DDC system manufacturer's authorized service representative. Include monthly preventive maintenance, repair or replacement of worn or defective components, cleaning, calibration and adjusting as required for proper operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

3.25 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.
- B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.
 - 1. Upgrade Notice: At least 30 days to allow Owner to schedule and access system and to upgrade computer equipment if necessary.

3.26 DEMONSTRATION

- A. Engage a factory-authorized service representative with complete knowledge of Project-specific system installed to train Owner's maintenance personnel to adjust, operate, and maintain DDC system.
- B. Extent of Training:
 - 1. Base extent of training on scope and complexity of DDC system indicated and training requirements indicated. Provide extent of training required to satisfy requirements indicated even if more than minimum training requirements are indicated.
 - 2. Inform Owner of anticipated training requirements if more than minimum training requirements are indicated.
 - 3. Minimum Training Requirements:
 - a. Provide not less than five days of training total.
 - b. Stagger training over multiple training classes to accommodate Owner's requirements. All training shall occur before end of warranty period.
- C. Training Schedule:

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1. Schedule training with Owner 20 business days before expected Substantial Completion.
2. Schedule training to provide Owner with at least 15 business days of notice in advance of training.
3. Training shall occur within normal business hours at a mutually agreed on time. Unless otherwise agreed to, training shall occur Monday through Friday, except on U.S. Federal holidays, with two morning sessions and two afternoon sessions. Each morning session and afternoon session shall be split in half with 15-minute break between sessions. Morning and afternoon sessions shall be separated by 30-minute lunch period. Training, including breaks and excluding lunch period, shall not exceed eight hours per day.
4. Provide staggered training schedule as requested by Owner.

D. Training Attendee List and Sign-in Sheet:

1. Request from Owner in advance of training a proposed attendee list with name, phone number and e-mail address.
2. Provide a preprinted sign-in sheet for each training session with proposed attendees listed and no fewer than six blank spaces to add additional attendees.
3. Preprinted sign-in sheet shall include training session number, date and time, instructor name, phone number and e-mail address, and brief description of content to be covered during session. List attendees with columns for name, phone number, e-mail address and a column for attendee signature or initials.
4. Circulate sign-in sheet at beginning of each session and solicit attendees to sign or initial in applicable location.
5. At end of each training day, send Owner an e-mail with an attachment of scanned copy (PDF) of circulated sign-in sheet for each session.

E. Training Attendee Headcount:

1. Plan in advance of training for five attendees.
2. Make allowance for Owner to add up to two attendees at time of training.
3. Headcount may vary depending on training content covered in session. Attendee access may be restricted to some training content for purposes of maintaining system security.

F. Attendee Training Manuals:

1. Provide each attendee with a color hard copy of all training materials and visual presentations.
2. Hard-copy materials shall be organized in a three-ring binder with table of contents and individual divider tabs marked for each logical grouping of subject matter. Organize material to provide space for attendees to take handwritten notes within training manuals.
3. In addition to hard-copy materials included in training manual, provide each binder with a sleeve or pocket that includes a DVD or flash drive with PDF copy of all hard-copy materials.

G. Instructor Requirements:

1. One or multiple qualified instructors, as required, to provide training.
2. Instructors shall have not less than five years of providing instructional training on not less than five past projects with similar DDC system scope and complexity to DDC system installed.

H. Organization of Training Sessions:

1. Organize training sessions into logical groupings of technical content and to reflect different levels of operators having access to system. Plan training sessions to accommodate the following three levels of operators:
 - a. Daily operators.
 - b. Advanced operators.
 - c. System managers and administrators.
2. Plan and organize training sessions to group training content to protect DDC system security. Some attendees may be restricted to some training sessions that cover restricted content for purposes of maintaining DDC system security.

I. Training Outline:

1. Submit training outline for Owner review at least 10 business day before scheduling training.
2. Outline shall include a detailed agenda for each training day that is broken down into each of four training sessions that day, training objectives for each training session and synopses for each lesson planned.

J. On-Site Training:

1. Owner will provide conditioned classroom or workspace with ample desks or tables, chairs, power and data connectivity for instructor and each attendee.
2. Instructor shall provide training materials, projector and other audiovisual equipment used in training.
3. Provide as much of training located on-site as deemed feasible and practical by Owner.
4. On-site training shall include regular walk-through tours, as required, to observe each unique product type installed with hands-on review of operation, calibration and service requirements.
5. Operator workstation provided with DDC system shall be used in training. If operator workstation is not indicated, provide a temporary workstation to convey training content.

K. Training Content for Daily Operators:

1. Basic operation of system.
2. Understanding DDC system architecture and configuration.
3. Understanding each unique product type installed including performance and service requirements for each.
4. Understanding operation of each system and equipment controlled by DDC system including sequences of operation, each unique control algorithm and each unique optimization routine.
5. Operating operator workstations, printers and other peripherals.
6. Logging on and off system.
7. Accessing graphics, reports and alarms.
8. Adjusting and changing set points and time schedules.
9. Recognizing DDC system malfunctions.

10. Understanding content of operation and maintenance manuals including control drawings.
 11. Understanding physical location and placement of DDC controllers and I/O hardware.
 12. Accessing data from DDC controllers.
 13. Operating portable operator workstations.
 14. Review of DDC testing results to establish basic understanding of DDC system operating performance and HVAC system limitations as of Substantial Completion.
 15. Running each specified report and log.
 16. Displaying and demonstrating each data entry to show Project-specific customizing capability. Demonstrating parameter changes.
 17. Stepping through graphics penetration tree, displaying all graphics, demonstrating dynamic updating, and direct access to graphics.
 18. Executing digital and analog commands in graphic mode.
 19. Demonstrating control loop precision and stability via trend logs of I/O for not less than 10 percent of I/O installed.
 20. Demonstrating DDC system performance through trend logs and command tracing.
 21. Demonstrating scan, update, and alarm responsiveness.
 22. Demonstrating spreadsheet and curve plot software, and its integration with database.
 23. Demonstrating on-line user guide, and help function and mail facility.
 24. Demonstrating multitasking by showing dynamic curve plot, and graphic construction operating simultaneously via split screen.
 25. Demonstrating the following for HVAC systems and equipment controlled by DDC system:
 - a. Operation of HVAC equipment in normal-off, -on and failed conditions while observing individual equipment, dampers and valves for correct position under each condition.
 - b. For HVAC equipment with factory-installed software, show that integration into DDC system is able to communicate with DDC controllers or gateways, as applicable.
 - c. Using graphed trends, show that sequence of operation is executed in correct manner, and HVAC systems operate properly through complete sequence of operation including seasonal change, occupied and unoccupied modes, warm-up and cool-down cycles and other modes of operation indicated.
 - d. Hardware interlocks and safeties function properly and DDC system performs correct sequence of operation after electrical power interruption and resumption after power is restored.
 - e. Reporting of alarm conditions for each alarm, and confirm that alarms are received at assigned locations, including operator workstations.
 - f. Each control loop responds to set point adjustment and stabilizes within time period indicated.
 - g. Sharing of previously graphed trends of all control loops to demonstrate that each control loop is stable and set points are being maintained.
- L. Training Content for Advanced Operators:
1. Making and changing workstation graphics.
 2. Creating, deleting and modifying alarms including annunciation and routing.
 3. Creating, deleting and modifying point trend logs including graphing and printing on an ad-hoc basis and operator-defined time intervals.

4. Creating, deleting and modifying reports.
5. Creating, deleting and modifying points.
6. Creating, deleting and modifying programming including ability to edit control programs off-line.
7. Creating, deleting and modifying system graphics and other types of displays.
8. Adding DDC controllers and other network communication devices such as gateways and routers.
9. Adding operator workstations.
10. Performing DDC system checkout and diagnostic procedures.
11. Performing DDC controllers operation and maintenance procedures.
12. Performing operator workstation operation and maintenance procedures.
13. Configuring DDC system hardware including controllers, workstations, communication devices and I/O points.
14. Maintaining, calibrating, troubleshooting, diagnosing and repairing hardware.
15. Adjusting, calibrating and replacing DDC system components.

M. Training Content for System Managers and Administrators:

1. DDC system software maintenance and backups.
2. Uploading, downloading and off-line archiving of all DDC system software and databases.
3. Interface with Project-specific, third-party operator software.
4. Understanding password and security procedures.
5. Adding new operators and making modifications to existing operators.
6. Operator password assignments and modification.
7. Operator authority assignment and modification.
8. Workstation data segregation and modification.

N. Video of Training Sessions:

1. Provide a digital video and audio recording of each training session. Create a separate recording file for each session.
2. Stamp each recording file with training session number, session name and date.
3. Provide Owner with two copies of digital files on DVDs or flash drives for later reference and for use in future training.
4. Owner retains right to make additional copies for intended training purposes without having to pay royalties.

END OF SECTION

SECTION 230923.11 - CONTROL VALVES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes control valves and actuators for DDC systems.
- B. Related Requirements:
 - 1. Section 230923 "Direct-Digital Control System for HVAC" control equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, and cable.

1.3 DEFINITIONS

- A. Cv: Design valve coefficient.
- B. DDC: Direct-digital control.
- C. NBR: Nitrile butadiene rubber.
- D. PTFE: Polytetrafluoroethylene
- E. RMS: Root-mean-square value of alternating voltage, which is the square root of the mean value of the square of the voltage values during a complete cycle.

1.4 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of the Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.
- C. Product Data: For each type of product, including the following:
 - 1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.

2. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
3. Product description with complete technical data, performance curves, and product specification sheets.
4. Installation, operation, and maintenance instructions, including factors affecting performance.

1.5 CLOSEOUT SUBMITTALS

- A. Submittals shall comply with the requirements of the Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Operation and Maintenance Data: For control valves to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASME Compliance: Fabricate and label products to comply with ASME Boiler and Pressure Vessel Code where required by authorities having jurisdiction.
- C. Ground Fault: Products shall not fail due to ground fault condition when suitably grounded.
- D. Determine control valve sizes and flow coefficients by ISA 75.01.01.
- E. Control valve characteristics and rangeability shall comply with ISA 75.11.01.
- F. Selection Criteria:
 1. Control valve shutoff classifications shall be FCI 70-2, Class IV or better unless otherwise indicated.
 2. Valve pattern, three-way or straight through, shall be as indicated on Drawings.
 3. Modulating straight-through pattern control valves shall have equal percentage flow-throttling characteristics unless otherwise indicated.
 4. Modulating three-way pattern water valves shall have linear flow-throttling characteristics. The total flow through the valve shall remain constant regardless of the valve's position.
 5. Fail positions unless otherwise indicated:
 - a. Heating Hot Water: Open.

- b. Terminal Unit Reheat Valve: Last position.
6. Globe-type control valves shall pass the design flow required with not more than 95 percent of stem lift unless otherwise indicated.
 7. Rotary-type control valves, such as ball valves, shall have Cv falling between 65 and 75 degrees of valve full open position and minimum valve Cv between 15 and 25 percent of open position.
 8. Selection shall consider viscosity, flashing, and cavitation corrections.
 9. Valves shall have stable operation throughout full range of operation, from design to minimum Cv.
 10. In water systems, select modulating control valves at terminal equipment for a design Cv based on a pressure drop of 3 psig at design flow unless otherwise indicated.
 11. Two-position control valves shall be line size unless otherwise indicated.
 12. In water systems, use ball- or globe-style control valves for two-position control.

2.2 BALL-STYLE CONTROL VALVES

A. Ball Valves with Single Port and Characterized Disk:

1. Pressure Rating for NPS 1 and Smaller: Nominal 600 WOG.
2. Pressure Rating for NPS 1-1/2 through NPS 2: Nominal 400 WOG.
3. Close-off Pressure: 200 psig.
4. Process Temperature Range: Zero to 212 deg F.
5. Body and Tail Piece: Cast bronze ASTM B 61, ASTM B 62, ASTM B 584, or forged brass with nickel plating.
6. End Connections: Threaded (NPT) ends.
7. Ball: Chrome-plated brass or bronze or 300 series stainless steel.
8. Stem and Stem Extension:
 - a. Material to match ball.
 - b. Blowout-proof design.
 - c. Sleeve or other approved means to allow valve to be opened and closed without damaging the insulation or the vapor barrier seal.
9. Ball Seats: Reinforced PTFE.
10. Stem Seal: Reinforced PTFE packing ring with a threaded packing ring follower to retain the packing ring under design pressure with the linkage removed. Alternative means, such as EPDM O-rings, are acceptable if an equivalent cycle endurance can be demonstrated by testing.
11. Flow Characteristic: Equal percentage.

B. Ball valves shall not be used for 3-way valve applications.

2.3 GLOBE-STYLE CONTROL VALVES

A. General Globe-Style Valve Requirements:

1. Globe-style control valve body dimensions shall comply with ISA 75.08.01.

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2. Construct the valves to be serviceable from the top.
3. For cage guided valves, trim shall be field interchangeable for different valve flow characteristics, such as equal percentage, linear, and quick opening.
4. Reduced trim for one nominal size smaller shall be available for industrial valves NPS 1 and larger.
5. Replaceable seats and plugs.
6. Furnish each control valve with a corrosion-resistant nameplate indicating the following:
 - a. Manufacturer's name, model number, and serial number.
 - b. Body and trim size.
 - c. Arrow indicating direction of flow.

B. Two-Way Globe Valves NPS 2 and Smaller:

1. Globe Style: Single port.
2. Body: Cast bronze or forged brass with ASME B16.5, Class 250 rating.
3. End Connections: Threaded.
4. Bonnet: Screwed.
5. Packing: PTFE V-ring.
6. Plug: Top guided.
7. Plug, Seat, and Stem: Brass or stainless steel.
8. Process Temperature Range: 35 to 248 deg F.
9. Ambient Operating Temperature: 35 to 150 deg F.
10. Leakage: FCI 70-2, Class IV.
11. Rangeability: 25 to 1.
12. Equal percentage flow characteristic.

C. Three-Way Globe Valves NPS 2 and Smaller:

1. Globe Style: Mix flow pattern.
2. Body: Cast bronze or forged brass with ASME B16.5, Class 250 rating.
3. End Connections: Threaded.
4. Bonnet: Screwed.
5. Packing: PTFE V-ring.
6. Plug: Top guided.
7. Plug, Seat, and Stem: Brass or stainless steel.
8. Process Temperature Range: 35 to 248 deg F.
9. Ambient Operating Temperature: 35 to 150 deg F.
10. Leakage: FCI 70-2, Class IV.
11. Rangeability: 25 to 1.
12. Linear flow characteristic.

D. Two-Way Globe Valves NPS 2-1/2 to NPS 6:

1. Globe Style: Single port.
2. Body: Cast iron complying with ASME B61.1, Class 125.
3. End Connections: Flanged, suitable for mating to ASME B16.5, Class 150 flanges.
4. Bonnet: Bolted.
5. Packing: PTFE cone-ring.
6. Plug: Top or bottom guided.

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7. Plug, Seat, and Stem: Brass or stainless steel.
8. Process Temperature Rating: 35 to 281 deg F.
9. Leakage: 0.1 percent of maximum flow.
10. Rangeability: Varies with valve size between 6 and 10 to 1.
11. Modified linear flow characteristic.

E. Three-Way Globe Valves NPS 2-1/2 to NPS 6:

1. Globe Style: Mix flow pattern.
2. Body: Cast iron complying with ASME B61.1, Class 125.
3. End Connections: Flanged suitable for mating to ASME B16.5, Class 150 flanges.
4. Bonnet: Bolted.
5. Packing: PTFE cone-ring.
6. Plug: Top or bottom guided.
7. Plug, Seat, and Stem: Brass or stainless steel.
8. Process Temperature Rating: 35 to 281 deg F.
9. Leakage: 0.1 percent of maximum flow.
10. Rangeability: Varies with valve size between 6 and 10 to 1.
11. Modified linear flow characteristic.

2.4 SOLENOID VALVES

A. Description:

1. Action: Either normally open or normally closed in the event of electrical power failure as required by the application.
2. Size to close against the system pressure.
3. Manual override capable.
4. Heavy-duty assembly.
5. Body: Brass or stainless steel.
6. Seats and Discs: NBR or PTFE.
7. Solenoid Enclosure: NEMA 250, Type 4.

2.5 ELECTRIC AND ELECTRONIC CONTROL VALVE ACTUATORS

- A. Actuators for Hydronic Control Valves: Capable of closing valve against system pump shutoff head.
- B. Position indicator and graduated scale on each actuator.
- C. Type: Motor operated, with or without gears, electric and electronic.
- D. Voltage: Voltage selection delegated to professional designing control system.
- E. Deliver torque required for continuous uniform movement of controlled device from limit to limit when operated at rated voltage.
- F. Function properly within a range of 85 to 120 percent of nameplate voltage.

G. Field Adjustment:

1. Spring Return Actuators: Easily switchable from fail open to fail closed in the field without replacement.
2. Gear Type Actuators: External manual adjustment mechanism to allow manual positioning when the actuator is not powered.

H. Two-Position Actuators: Single direction, spring return type.

I. Modulating Actuators:

1. Operation: Capable of stopping at all points across full range, and starting in either direction from any point in range.
2. Control Input Signal:
 - a. Three Point, Tristate, or Floating Point: Clockwise and counter-clockwise inputs. One input drives actuator to open position and other input drives actuator to close position. No signal of either input remains in last position.
 - b. Proportional: Actuator drives proportional to input signal and modulates throughout its angle of rotation. Suitable for zero- to 10- or 2- to 10-V dc and 4- to 20-mA signals.

J. Position Feedback:

1. Provide a position indicator and graduated scale on each actuator indicating open and closed travel limits.

K. Fail-Safe:

1. Where indicated, provide actuator to fail to an end position.
2. Internal spring return mechanism to drive controlled device to an end position (open or close) on loss of power.
3. Batteries, capacitors, and other non-mechanical forms of fail-safe operation are acceptable only where uniquely indicated.

L. Integral Overload Protection:

1. Provide against overload throughout the entire operating range in both directions.
2. Electronic overload, digital rotation sensing circuitry, mechanical end switches, or magnetic clutches are acceptable methods of protection.

M. Valve Attachment:

1. Unless otherwise required for valve interface, provide an actuator designed to be directly coupled to valve shaft without the need for connecting linkages.
2. Attach actuator to valve drive shaft in a way that ensures maximum transfer of power and torque without slippage.
3. Bolt and set screw method of attachment is acceptable only if provided with at least two points of attachment.

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N. Temperature and Humidity:

1. Temperature: Suitable for operating temperature range encountered by application with minimum operating temperature range of minus 20 to plus 120 deg F.
2. Humidity: Suitable for humidity range encountered by application; minimum operating range shall be from 5 to 95 percent relative humidity, non-condensing.

O. Enclosure:

1. Suitable for ambient conditions encountered by application.
2. NEMA 250, Type 2 for indoor and protected applications.
3. NEMA 250, Type 4 or Type 4X for outdoor and unprotected applications.
4. Provide actuator enclosure with heater and control where required by application.

P. Stroke Time:

1. Operate valve from fully closed to fully open within seconds.
2. Operate valve from fully open to fully closed within seconds.
3. Move valve to failed position within seconds.
4. Select operating speed to be compatible with equipment and system operation.

Q. Sound:

1. Spring Return: 62 dBA.
2. Non-Spring Return: 45 dBA.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for valves installed in piping to verify actual locations of piping connections before installation.
- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 CONTROL VALVE APPLICATIONS

A. Control Valves:

1. Select from valves specified in "Control Valves" Article to achieve performance requirements and characteristics indicated while subjected to full range of system operation encountered.

3.3 INSTALLATION, GENERAL

- A. Furnish and install products required to satisfy most stringent requirements indicated.
- B. Install products level, plumb, parallel, and perpendicular with building construction.
- C. Properly support instruments, tubing, piping, wiring, and conduits to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment when subjected to a force.
- D. Provide ceiling, floor, roof, and wall openings and sleeves required by installation. Before proceeding with drilling, punching, or cutting, check location first for concealed products that could potentially be damaged. Patch, flash, grout, seal, and refinish openings to match adjacent condition.
- E. Firestop penetrations made in fire-rated assemblies and seal penetrations made in acoustically rated assemblies.
- F. Fastening Hardware:
 - 1. Stillson wrenches, pliers, and other tools that will cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for assembling and tightening nuts.
 - 2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
 - 3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.
- G. Install products in locations that are accessible and that will permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

3.4 ELECTRIC POWER

- A. Furnish and install electrical power to products requiring electrical connections.
- B. Furnish and install circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."
- C. Furnish and install power wiring. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- D. Furnish and install raceways. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems."

3.5 CONTROL VALVES

- A. Install pipe reducers for valves smaller than line size. Position reducers as close to valve as possible but at distance to avoid interference and impact to performance. Install with manufacturer-recommended clearance.

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- B. Install flanges or unions to allow drop-in and -out valve installation.
- C. Install pressure temperature taps in piping upstream and downstream of each control valve larger than NPS 2.
- D. Valve Orientation:
 - 1. Where possible, install globe and ball valves installed in horizontal piping with stems upright and not more than 15 degrees off of vertical, not inverted.
 - 2. Install valves in a position to allow full stem movement.
- E. Clearance:
 - 1. Locate valves for easy access and provide separate support of valves that cannot be handled by service personnel without hoisting mechanism.
 - 2. Install valves with at least 12 inches of clear space around valve and between valves and adjacent surfaces.
- F. Threaded Valves:
 - 1. Note internal length of threads in valve ends, and proximity of valve internal seat or wall, to determine how far pipe should be threaded into valve.
 - 2. Align threads at point of assembly.
 - 3. Apply thread compound to external pipe threads, except where dry seal threading is specified.
 - 4. Assemble joint, wrench tight. Apply wrench on valve end as pipe is being threaded.
- G. Flanged Valves:
 - 1. Align flange surfaces parallel.
 - 2. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly with a torque wrench.

3.6 CONNECTIONS

- A. Connect electrical devices and components to electrical grounding system. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.7 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Each piece of wire and cable shall have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Install engraved nameplate with valve identification on valve and on face of ceiling directly below valves concealed above ceilings.

3.8 CLEANING

- A. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from exposed interior and exterior surfaces.
- B. Wash and shine glazing.
- C. Polish glossy surfaces to a clean shine.

3.9 CHECKOUT PROCEDURES

- A. Control Valve Checkout:
 - 1. Check installed products before continuity tests, leak tests, and calibration.
 - 2. Check valves for proper location and accessibility.
 - 3. Check valves for proper installation for direction of flow, elevation, orientation, insertion depth, or other applicable considerations that will impact performance.
 - 4. Verify that control valves are installed correctly for flow direction.
 - 5. Verify that valve body attachment is properly secured and sealed.
 - 6. Verify that valve actuator and linkage attachment are secure.
 - 7. Verify that actuator wiring is complete, enclosed, and connected to correct power source.
 - 8. Verify that valve ball, disc, and plug travel are unobstructed.
 - 9. After piping systems have been tested and put into service, but before insulating and balancing, inspect each valve for leaks. Adjust or replace packing to stop leaks. Replace the valve if leaks persist.

3.10 ADJUSTMENT, CALIBRATION, AND TESTING

- A. Stroke and adjust control valves following manufacturer's recommended procedure, from 100 percent open to 100 percent closed back to 100 percent open.
- B. Stroke control valves with pilot positioners. Adjust valve and positioner following manufacturer's recommended procedure, so valve is 100 percent closed, 50 percent closed, and 100 percent open at proper air pressures.
- C. Check and document open and close cycle times for applications with a cycle time of less than 30 seconds.
- D. For control valves equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

END OF SECTION

SECTION 230923.12 - CONTROL DAMPERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes the following types of control dampers and actuators for DDC systems:
 - 1. Rectangular control dampers.
 - 2. Round control dampers.
 - 3. General control-damper actuator requirements.
 - 4. Electric and electronic actuators.
- B. Related Requirements:
 - 1. Section 230923 "Direct-Digital Control System for HVAC" for control equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, and cable.

1.3 DEFINITIONS

- A. DDC: Direct-digital control.
- B. RMS: Root-mean-square value of alternating voltage, which is the square root of the mean value of the square of the voltage values during a complete cycle.

1.4 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of the Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.
- C. Product Data: For each type of product, including the following:
 - 1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
 - 2. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control

signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.

3. Product description with complete technical data, performance curves, and product specification sheets.
4. Installation instructions, including factors affecting performance.

D. Shop Drawings:

1. Include plans, elevations, sections, and mounting details.
2. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Submittals shall comply with the requirements of the Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Coordination Drawings: Plan drawings and corresponding product installation details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 1. Product installation location shown in relationship to room, duct, and equipment.
 2. Size and location of wall access panels for control dampers and actuators installed behind walls.
 3. Size and location of ceiling access panels for control dampers and actuators installed above inaccessible ceilings.

1.6 CLOSEOUT SUBMITTALS

- A. Submittals shall comply with the requirements of the Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Operation and Maintenance Data: For control dampers to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

- B. ASME Compliance: Fabricate and label products to comply with ASME Boiler and Pressure Vessel Code where required by authorities having jurisdiction.
- C. Ground Fault: Products shall not fail due to ground fault condition when suitably grounded.
- D. Backup Power Source: Systems and equipment served by a backup power source shall have associated control damper actuators served from a backup power source.
- E. Selection Criteria:
 - 1. Dampers shall have stable operation throughout full range of operation, from design to minimum airflow over varying pressures and temperatures encountered.
 - 2. Select modulating dampers for a pressure drop of 2 percent of fan total static pressure unless otherwise indicated.
 - 3. Two-position dampers shall be full size of duct or equipment connection unless otherwise indicated.

2.2 RECTANGULAR CONTROL DAMPERS

- A. General Requirements:
 - 1. Unless otherwise indicated, use parallel blade configuration for two-position control, equipment isolation service, and when mixing two airstreams. For other applications, use opposed blade configuration.
 - 2. Factory assemble multiple damper sections to provide a single damper assembly of size required by the application.
 - 3. Damper actuator shall be factory installed by damper manufacturer as integral part of damper assembly. Coordinate actuator location and mounting requirements with damper manufacturer.
- B. Rectangular Dampers with Steel Airfoil Blades:
 - 1. Performance:
 - a. Leakage: AMCA 511, Class 1A. Leakage shall not exceed 3 cfm/sq. ft. against 1-in. wg differential static pressure.
 - b. Pressure Drop: 0.06-in. wg at 1500 fpm across a 24-by-24-inch damper when tested according to AMCA 500-D, figure 5.3.
 - c. Velocity: Up to 6000 fpm.
 - d. Temperature: Minus 40 to plus 185 deg F.
 - e. Pressure Rating: Damper close-off pressure equal to fan shutoff pressure with a maximum blade deflection of 1/200 of blade length.
 - f. Damper shall have AMCA seal for both air leakage and air performance.
 - 2. Construction:
 - a. Frame:
 - 1) Material: ASTM A 653/A 653M galvanized-steel profiles, 0.06 inch thick.

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- 2) Hat-shaped channel with integral flanges. Mating face shall be a minimum of 1 inch.
- 3) Width not less than 5 inches.

b. Blades:

- 1) Hollow, airfoil, galvanized steel.
- 2) Parallel or opposed blade configuration as required by application.
- 3) Material: ASTM A 653/A 653M galvanized steel, 0.05 inch thick.
- 4) Width not to exceed 6 inches.
- 5) Length as required by close-off pressure, not to exceed 48 inches.

c. Seals:

- 1) Blades: Replaceable, mechanically attached extruded silicone, vinyl, or plastic composite.
- 2) Jambs: Stainless steel, compression type.

d. Axles: 0.5-inch-diameter plated or stainless steel, mechanically attached to blades.

e. Bearings:

- 1) Stainless steel mounted in frame.
- 2) Where blade axles are installed in vertical position, provide thrust bearings.

f. Linkage:

- 1) Concealed in frame.
- 2) Constructed of aluminum and plated or stainless steel.
- 3) Hardware: Stainless steel.

g. Transition:

- 1) For round and flat oval duct applications, provide damper assembly with integral transitions to mate to adjoining field connection.
- 2) Factory mount damper in a sleeve with a close transition to mate to field connection.
- 3) Damper size and sleeve shall be connection size plus 2 inches.
- 4) Sleeve length shall be not less than 12 inches for dampers without jackshafts and shall be not less than 16 inches for dampers with jackshafts.
- 5) Sleeve material shall match adjacent duct.

h. Additional Corrosion Protection for Corrosive Environments:

- 1) Provide epoxy finish for surfaces in contact with airstream.
- 2) Axles, damper linkage, and hardware shall be constructed of Type 316L stainless steel.

C. Insulated Rectangular Dampers:

1. Performance:

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- a. Leakage: AMCA 511, Class 1A. Leakage shall not exceed 3 cfm/sq. ft. against 1-in. wg differential static pressure and shall not exceed 4.9 cfm/sq. ft. against 4-in. wg differential static pressure at minus 40 deg F.
 - b. Pressure Drop: 0.1-in. wg at 1500 fpm across a 24-by-24-inch damper when tested according to AMCA 500-D, figure 5.3.
 - c. Velocity: Up to 4000 fpm.
 - d. Temperature: Minus 100 to plus 185 deg F.
 - e. Pressure Rating: Damper close-off pressure equal to fan shutoff pressure with a maximum blade deflection of 1/200 of blade length.
 - f. Damper shall have AMCA seal for both air leakage and air performance.
2. Construction:
- a. Frame:
 - 1) Material: ASTM B 211, Alloy 6063 T5 extruded-aluminum profiles, 0.08 inch thick.
 - 2) C-shaped channel with integral flange(s). Mating face shall be a minimum of 1 inch.
 - 3) Width not less than 4 inches.
 - 4) Entire frame shall be thermally broken by means of polyurethane resin pockets, complete with thermal cuts.
 - 5) Damper frame shall be insulated with polystyrofoam on four sides.
 - b. Blades:
 - 1) Hollow shaped, extruded aluminum.
 - 2) Blades shall be internally insulated with expanded polyurethane foam and shall be thermally broken. Complete blade shall have an insulating factor of R-2.29 and a temperature index of 55.
 - 3) Parallel or opposed blade configuration as required by application.
 - 4) Material: ASTM B 211, Alloy 6063 T5 aluminum, 0.08 inch thick.
 - 5) Width not to exceed 6 inches.
 - 6) Length as required by close-off pressure, not to exceed 48 inches.
 - c. Seals: Blade and frame seals shall be of flexible silicone and secured in an integral slot within the aluminum extrusions.
 - d. Axles: 0.44-inch-diameter plated or stainless steel, mechanically attached to blades.
 - e. Bearings:
 - 1) Bearings shall be composed of a Celcon inner bearing fixed to axle, rotating within a polycarbonate outer bearing inserted in the frame, resulting in no metal-to-metal or metal-to-plastic contact.
 - 2) Where blade axles are installed in vertical position, provide thrust bearings.
 - f. Linkage:
 - 1) Concealed in frame.
 - 2) Constructed of aluminum and plated or stainless steel.

3) Hardware: Stainless steel.

g. Transition:

- 1) For round and flat oval duct applications, provide damper assembly with integral transitions to mate to adjoining field connection.
- 2) Factory mount damper in a sleeve with a close transition to mate to field connection.
- 3) Damper size and sleeve shall be connection size plus 2 inches.
- 4) Sleeve length shall be not less than 12 inches for dampers without jackshafts and shall be not less than 16 inches for dampers with jackshafts.
- 5) Sleeve material shall match adjacent duct.

h. Additional Corrosion Protection for Corrosive Environments:

- 1) Provide anodized finish for aluminum surfaces in contact with airstream. Anodized finish shall be a minimum of 0.0007 inch thick.
- 2) Axles, damper linkage, and hardware shall be constructed of Type 316L stainless steel.

2.3 ROUND CONTROL DAMPERS

A. Round Dampers, Sleeve Type:

1. Performance:

- a. Leakage: Leakage shall not exceed 0.15 cfm/in. of perimeter blade at 4-in. wg differential static pressure.
- b. Pressure Drop: 0.02-in. wg at 1500 fpm across a 12-inch damper when tested according to AMCA 500-D, figure 5.3.
- c. Velocity: Up to 4000 fpm.
- d. Temperature: Minus 25 to plus 200 deg F.
- e. Pressure Rating: 8-in. wg for sizes through 12 inches, 6-in. wg for larger sizes.

2. Construction:

a. Frame:

- 1) Material: Galvanized steel, 0.04 in thick.
- 2) Outward rolled stiffener beads positioned approximately 1 inch inboard of each end.
- 3) Sleeve-type connection for mating to adjacent ductwork.
- 4) Size Range: 4 to 24 inches.
- 5) Length not less than 7 inches.
- 6) Provide 2-inch sheet metal stand-off for mounting actuator.

b. Blade: Double-thickness circular flat blades sandwiched together and constructed of galvanized steel.

- c. Blade Seal: Polyethylene foam seal sandwiched between two sides of blades and fully encompassing blade edge.
- d. Axle: 0.5-inch-diameter plated or stainless steel, mechanically attached to blade.
- e. Bearings: Stainless-steel sleeve pressed into frame.

2.4 GENERAL CONTROL-DAMPER ACTUATORS REQUIREMENTS

- A. Actuators shall operate related damper(s) with sufficient reserve power to provide smooth modulating action or two-position action and proper speed of response at velocity and pressure conditions to which the damper is subjected.
- B. Actuators shall produce sufficient power and torque to close off against the maximum system pressures encountered. Actuators shall be sized to close off against one and a half (1.5) times the fan shutoff pressure as a minimum requirement.
- C. The total damper area operated by an actuator shall not exceed 80 percent of manufacturer's maximum area rating.
- D. Provide one actuator for each damper assembly where possible. Multiple actuators required to drive a single damper assembly shall operate in unison.
- E. Avoid the use of excessively oversized actuators which could overdrive and cause linkage failure when the damper blade has reached either its full open or closed position.
- F. Use jackshafts and shaft couplings in lieu of blade-to-blade linkages when driving axially aligned damper sections.
- G. Provide mounting hardware and linkages for connecting actuator to damper.
- H. Select actuators to fail in desired position in the event of a power failure.
- I. Actuator Fail Positions: As indicated below:
 - 1. Exhaust Air: Close.
 - 2. Outdoor Air: Close.
 - 3. Supply Air: Open.
 - 4. Return Air: Open.

2.5 ELECTRIC AND ELECTRONIC ACTUATORS

- A. Type: Motor operated, with or without gears, electric and electronic.
- B. Voltage:
 - 1. Voltage selection is delegated to professional designing control system.
 - 2. Actuator shall deliver torque required for continuous uniform movement of controlled device from limit to limit when operated at rated voltage.

3. Actuator shall function properly within a range of 85 to 120 percent of nameplate voltage.
- C. Field Adjustment:
1. Spring return actuators shall be easily switchable from fail open to fail closed in the field without replacement.
 2. Provide gear-type actuators with an external manual adjustment mechanism to allow manual positioning of the damper when the actuator is not powered.
- D. Two-Position Actuators: Single direction, spring return or reversing type.
- E. Modulating Actuators:
1. Capable of stopping at all points across full range, and starting in either direction from any point in range.
 2. Control Input Signal:
 - a. Three Point, Tristate, or Floating Point: Clockwise and counter-clockwise inputs. One input drives actuator to open position, and other input drives actuator to close position. No signal of either input remains in last position.
 - b. Proportional: Actuator drives proportional to input signal and modulates throughout its angle of rotation. Suitable for zero- to 10- or 2- to 10-V dc and 4- to 20-mA signals.
- F. Fail-Safe:
1. Where indicated, provide actuator to fail to an end position.
 2. Internal spring return mechanism to drive controlled device to an end position (open or close) on loss of power.
 3. Batteries, capacitors, and other non-mechanical forms of fail-safe operation are acceptable only where uniquely indicated.
- G. Integral Overload Protection:
1. Provide against overload throughout the entire operating range in both directions.
 2. Electronic overload, digital rotation sensing circuitry, mechanical end switches, or magnetic clutches are acceptable methods of protection.
- H. Damper Attachment:
1. Unless otherwise required for damper interface, provide actuator designed to be directly coupled to damper shaft without need for connecting linkages.
 2. Attach actuator to damper drive shaft in a way that ensures maximum transfer of power and torque without slippage.
 3. Bolt and set screw method of attachment is acceptable only if provided with at least two points of attachment.
- I. Temperature and Humidity:

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1. Temperature: Suitable for operating temperature range encountered by application with minimum operating temperature range of minus 20 to plus 120 deg F.
2. Humidity: Suitable for humidity range encountered by application; minimum operating range shall be from 5 to 95 percent relative humidity, non-condensing.

J. Enclosure:

1. Suitable for ambient conditions encountered by application.
2. NEMA 250, Type 2 for indoor and protected applications.
3. NEMA 250, Type 4 or Type 4X for outdoor and unprotected applications.
4. Provide actuator enclosure with a heater and controller where required by application.

K. Stroke Time:

1. Operate damper from fully closed to fully open within seconds.
2. Operate damper from fully open to fully closed within seconds.
3. Move damper to failed position within 10 seconds.
4. Select operating speed to be compatible with equipment and system operation.
5. Actuators operating in smoke control systems comply with governing code and NFPA requirements.

L. Sound:

1. Spring Return: 62 dBA.
2. Non-Spring Return: 45 dBA.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for dampers and instruments installed in duct systems to verify actual locations of connections before installation.
- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Furnish and install products required to satisfy most stringent requirements indicated.
- B. Properly support dampers and actuators, wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment when subjected to a force.

- C. Provide ceiling, floor, roof, and wall openings and sleeves required by installation. Before proceeding with drilling, punching, or cutting, check location first for concealed products that could potentially be damaged. Patch, flash, grout, seal, and refinish openings to match adjacent condition.
- D. Seal penetrations made in fire-rated and acoustically rated assemblies.
- E. Fastening Hardware:
 - 1. Stillson wrenches, pliers, or other tools that will cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for assembling and tightening nuts.
 - 2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
 - 3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.
- F. Install products in locations that are accessible and that will permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

3.3 ELECTRIC POWER

- A. Furnish and install electrical power to products requiring electrical connections.
- B. Furnish and install circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."
- C. Furnish and install power wiring. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- D. Furnish and install raceways. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems."

3.4 CONTROL DAMPERS

- A. Install smooth transitions, not exceeding 30 degrees, to dampers smaller than adjacent duct. Install transitions as close to damper as possible but at distance to avoid interference and impact to performance. Consult manufacturer for recommended clearance.
- B. Clearance:
 - 1. Locate dampers for easy access and provide separate support of dampers that cannot be handled by service personnel without hoisting mechanism.
 - 2. Install dampers with at least 24 inches of clear space on sides of dampers requiring service access.
- C. Service Access:
 - 1. Dampers and actuators shall be accessible for visual inspection and service.

2. Install access door(s) in duct or equipment located upstream of damper to allow service personnel to hand clean any portion of damper, linkage, and actuator. Comply with requirements in Section 233300 "Air Duct Accessories."
- D. Install dampers straight and true, level in all planes, and square in all dimensions. Install supplementary structural steel reinforcement for large multiple-section dampers if factory support alone cannot handle loading.
- E. Attach actuator(s) to damper drive shaft.
- F. For duct-mounted and equipment-mounted dampers installed outside of equipment, install a visible and accessible indication of damper position from outside.

3.5 CONNECTIONS

- A. Connect electrical devices and components to electrical grounding system. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.6 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Each piece of wire and cable shall have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."Section 16075 "Electrical Identification."
- B. Install engraved nameplate with damper identification on damper and on face of ceiling where damper is concealed above ceiling.

3.7 CHECKOUT PROCEDURES

- A. Control-Damper Checkout:
 1. Check installed products before continuity tests, leak tests, and calibration.
 2. Check dampers for proper location and accessibility.
 3. Verify that control dampers are installed correctly for flow direction.
 4. Verify that proper blade alignment, either parallel or opposed, has been provided.
 5. Verify that damper frame attachment is properly secured and sealed.
 6. Verify that damper actuator and linkage attachment are secure.
 7. Verify that actuator wiring is complete, enclosed, and connected to correct power source.
 8. Verify that damper blade travel is unobstructed.

3.8 ADJUSTMENT, CALIBRATION, AND TESTING:

- A. Stroke and adjust control dampers following manufacturer's recommended procedure, from 100 percent open to 100 percent closed back to 100 percent open.

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- B. Stroke control dampers with pilot positioners. Adjust damper and positioner following manufacturer's recommended procedure, so damper is 100 percent closed, 50 percent closed, and 100 percent open at proper air pressure.
- C. Check and document open and close cycle times for applications with a cycle time of less than 30 seconds.
- D. For control dampers equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

END OF SECTION

SECTION 230923.13 - ENERGY METERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes thermal and electric power energy meters that connect to DDC systems.
- B. Related Requirements:
 - 1. Section 230923 "Direct-Digital Control System for HVAC" for control equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, and cable.
- C. Sustainable Design Requirements: Work included in this specification shall conform to the US Green Building Council LEED requirements listed in Section 018113.23 "Sustainable Design Requirements - LEED 2009 for Schools."

1.3 DEFINITIONS

- A. DDC: Direct-digital control.
- B. Ethernet: Local area network based on IEEE 802.3.1 standards.
- C. Firmware: Software (programs or data) that has been written onto read-only memory (ROM). Firmware is a combination of software and hardware. Storage media with ROMs that have data or programs recorded on them are firmware.
- D. I/O: Input/output.
- E. RMS: Root-mean-square value of alternating voltage, which is the square root of the mean value of the square of the voltage values during a complete cycle.
- F. RS-232: A TIA standard for asynchronous serial data communications between terminal devices.
- G. RS-485: A TIA standard for multipoint communications using two twisted pairs.
- H. RTD: Resistance temperature detector.

1.4 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 “Submittal Procedures” and the individual sections specifying the work.
- B. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.
- C. Product Data: For each type of product, including the following:
 - 1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
 - 2. Operating characteristics, electrical characteristics, and furnished accessories indicating electrical power requirements.
 - 3. Product description with complete technical data, performance curves, and product specification sheets.
- D. Sustainable Design Submittals:
 - 1. Product Data: For continuous metering equipment for energy consumption.
- E. Shop Drawings:
 - 1. Include plans, elevations, sections, and mounting details.
 - 2. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 “Submittal Procedures” and the individual sections specifying the work.
- B. Product Certificates: For each product requiring a certificate.

1.6 CLOSEOUT SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 “Submittal Procedures” and the individual sections specifying the work.
- B. Operation and Maintenance Data: For energy meters to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 THERMAL ENERGY METERS

- A. Performance Requirements: Manufacturer shall certify that each energy meter indicated complies with specified performance requirements and characteristics.
1. Product certificates are required.
- B. Insertion-Type Thermal Energy Meters:
1. Description:
 - a. Factory-packaged meter consisting of supply and return temperature sensors, flow sensor, digital display, keypad user interface, installation hardware, color-coded interconnecting cabling, and installation instructions.
 - b. Each thermal energy meter shall be individually calibrated and provided with calibration certification traceable to NIST.
 2. Alphanumeric display of the following on face of enclosure:
 - a. Total energy consumption.
 - b. Energy rate.
 - c. Flow rate.
 - d. Supply temperature.
 - e. Return temperature.
 - f. Visual indication of power status (on/off) on face of enclosure.
 3. Electronics Enclosure:
 - a. Remote from temperature and flow sensors.
 - b. NEMA 250, Type 12 or Type 13 for indoor applications and NEMA 250, Type 4 or Type 4X for outdoor applications.
 - c. Labeled terminal strip for field wiring connections.
 4. Programming:
 - a. Factory programmed for specific application and field programmable through keypad on face of enclosure.
 - b. Programmed parameters and total energy consumption shall be stored in non-volatile EEPROM memory.
 5. Output Signals:
 - a. Total Energy Consumption: Isolated solid-state dry contact with 100 mA, 50-V rating and contact duration of 0.5, 1, 2, or 6 seconds.
 - b. Energy Rate, Flow Rate, Supply Temperature, Return Temperature: 4 to 20 mA or zero- to 10-V dc for each.
 - c. In lieu of hardwired analog signals, a serial communication interface may be used.

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6. Serial Communication Interface: Compatible with host to share total energy consumption, energy rate, flow rate, and supply and return temperature data.
7. Temperature Sensors:
 - a. Temperature range matched to application.
 - b. Differential temperature accuracy within 0.15 deg F over the calibrated range.
 - c. NEMA 250, Type 4 junction box with thermal isolation.
 - d. Stainless-steel thermowell with NPS 1/2 NPT connection for each sensor.
8. Flow Sensor:
 - a. Suitable for an operating pressure of at least 200 psig.
 - b. Meters in hot-water systems shall be suitable for maximum system temperatures encountered, but not less than 250 deg F.
 - c. Pressure drop not to exceed 1 psig at 20-fps flow velocity in NPS 2 pipe and decreasing in large pipe with lower velocity.
 - d. Sensor Accuracy:
 - 1) Within 1 percent of actual flow between the flow velocity range of 3 to 30 fps.
 - 2) Within 2 percent of actual flow between the flow velocity range of 0.4 to 20 fps.
 - 3) Within 0.5 percent of actual reading at the calibrated velocity.
 - e. Wet calibrate and tag each sensor to standards traceable to NIST, and provide each sensor with a certificate of calibration.
 - f. Provide single turbine sensors for pipe size NPS 2 and smaller. Provide dual turbine sensors for pipe size NPS 2-1/2 and larger. Provide bidirectional dual turbine sensors where installed in bypass piping.
 - g. For sensors with dual contra-rotating turbine elements, provide each turbine element with its own rotational sensing system and an averaging circuit to reduce measurement errors due to a poor flow profile.
 - h. Rotational sensing of each turbine shall be accomplished electronically by sensing impedance change. The sensor shall have an integral frequency output linear with flow rate and individual top and bottom turbine outputs for diagnostic purposes.
 - i. Provide the flow sensor complete with installation hardware necessary to enable insertion and removal from the pipe without system shutdown.
 - j. Construct turbine elements of polypropylene with sapphire jewel bearings and tungsten carbide shafts. Construct wetted metal components of Type 316 stainless steel, including the installation hardware.
 - k. House the sensor electronics in a NEMA 250, Type 4 weathertight aluminum enclosure with a gasketed cover. Housing shall include connection for field-installed conduit.
 - l. Sensor cable length shall be sufficient to connect to display module.
 - m. Sensor housing shall have full-port ball valve for system isolation.
9. Power Supply:
 - a. Field Power: 120-V ac, 60 Hz unless otherwise required by the application.

b. Internal Power: As required by flow meter.

C. In-Line, Compact-Type Thermal Energy Meters:

1. Description:

- a. Factory-packaged meter consisting of supply and return temperature sensors, flow sensor, digital display, operator interface, installation hardware, interconnecting cabling, and installation instructions.
- b. Each thermal energy meter shall be individually calibrated and provided with calibration certifications traceable to NIST.
- c. Meter limited to flow rates between 0.8 and 38 gpm.
- d. Meter mode of operation shall be field configurable to accommodate two pipe systems that change from between heating and cooling.

2. Alphanumeric display of the following on face of enclosure:

- a. Total energy consumption.
- b. Energy rate.
- c. Flow rate.
- d. Supply temperature.
- e. Return temperature.

3. Diagnostic Lights:

- a. Meter equipped with diagnostic indicator lights that confirm the operation of the microprocessor and its input circuitry.
- b. Red LED labeled "BTU" shall flash as energy is transferred.
- c. Red LED labeled "FLOW" shall flash at a rate that is proportional to the liquid flow rate. An unlit LED indicates no flow signal.

4. Programming:

- a. Meter shall be factory programmed for specific application.
- b. Programmed parameters and total energy consumption shall be stored in non-volatile memory.

5. Output Signals:

- a. Mode 1 and Mode 2 Total Energy Consumption: Isolated solid-state dry contact with 100 mA, 50-V rating and contact duration of 0.5, 1, 2, or 6 seconds.
- b. Factory-set isolated analog output for energy rate, flow rate, or temperature difference: 4 to 20 mA, zero to 5 or 10 V.
- c. In lieu of hardwired output signals, a serial communication interface may be used.

6. Serial Communication Interface: Compatible with host to share total energy consumption, energy rate, flow rate, and supply and return temperature data.

7. Temperature Sensors:

- a. Temperature range matched to application.

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- b. Differential temperature accuracy within 0.15 deg F over the calibrated range.
 - c. One temperature sensor shall be built into the body of the flow sensor.
 - d. Second sensor shall be provided with brass thermowell with NPS 1/2 sweat fitting or NPS 1/4 NPT connection.
8. Flow Sensor:
- a. Ambient Temperature: 40 to 120 deg F.
 - b. Process Temperature: 32 to 200 deg F.
 - c. Maximum Process Pressure: 400 psig.
 - d. Pressure Drop: 3 psig at 38 gpm.
 - e. Accuracy:
 - 1) Within 1 percent of actual flow over flow rate range of 5.7 to 38 gpm.
 - 2) Within 2 percent of actual flow over flow rate range of 0.8 to 38 gpm.
 - 3) Within 0.5 percent of actual reading at the calibrated velocity.
 - f. Construct flow sensor body of brass.
 - g. Furnish with two tail pieces to facilitate connection to the piping system. One end of each tail piece shall be a compression fitting with retaining nut, and the other end shall either be a sweat fitting for copper or a threaded nipple with NPT threads.
 - h. Process Connections: NPS 3/4 or NPS 1.
 - i. House electronics in a NEMA 250, Type 4 weathertight aluminum enclosure with a gasketed cover. Housing shall include connection for field-installed conduit.
 - j. Sensor cable length shall be sufficient to connect to display module.
9. Power Supply:
- a. Field Power: 24-V ac, 50 or 60 Hz unless otherwise required by the application.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for instruments installed in piping to verify actual locations of connections before installation.
- C. Examine roughing-in for instruments installed in duct systems to verify actual locations of connections before installation.
- D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 THERMAL ENERGY METER APPLICATIONS

- A. Building heating.
- B. Domestic hot water, non-kitchen use.
- C. Domestic hot water, kitchen use.

3.3 INSTALLATION, GENERAL

- A. Install products level, plumb, parallel, and perpendicular with building construction.
- B. Support instruments, tubing, piping wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment when subjected to a force.
- C. Install products in locations that are accessible and that will permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

3.4 ELECTRIC POWER

- A. Furnish and install electrical power to products requiring electrical connections.
- B. Furnish and install circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."
- C. Furnish and install power wiring. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- D. Furnish and install raceways. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems."

3.5 MAINTENANCE SERVICE

- A. Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 24 months' full maintenance by manufacturer's authorized service representative. Include annual preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

3.6 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain instrumentation and control devices.

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- B. Coordinate video with operation and maintenance manuals and classroom instruction for use by Owner in operating, maintaining, and troubleshooting.
- C. Record videos on DVD disks.
- D. Owner shall have right to make additional copies of video for internal use without paying royalties.

END OF SECTION

SECTION 230923.14 - FLOW INSTRUMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Airflow sensors.
2. Airflow transmitters.
3. Liquid flow switches.

B. Related Requirements:

1. Section 230923 "Direct-Digital Control System for HVAC" for control equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, and cable.

- C. Sustainable Design Requirements: Work included in this specification shall conform to the US Green Building Council LEED requirements listed in Section 018113.23 "Sustainable Design Requirements - LEED 2009 for Schools."

1.3 DEFINITIONS

- A. Ethernet: Local area network based on IEEE 802.3 standards.
- B. HART: Highway addressable remote transducer protocol is the global standard for sending and receiving digital information across analog wires between smart devices and control or monitoring systems through bi-directional communication that provides data access between intelligent field instruments and host systems. A host can be any software application from technician's hand-held device or laptop to a plant's process control, asset management, safety, or other system using any control platform.
- C. PEEK: polyetheretherketone.
- D. PTFE: Polytetrafluoroethylene.
- E. PPS: Polyphenylene sulfide.
- F. RS-485: A TIA standard for multipoint communications using two twisted pairs.

- G. RTD: Resistance temperature detector.
- H. TCP/IP: Transport control protocol/Internet protocol incorporated into Microsoft Windows.

1.4 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 “Submittal Procedures” and the individual sections specifying the work.
- B. Product Data: For each type of product, including the following. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.
 - 1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
 - 2. Operating characteristics; electrical characteristics; and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
 - 3. Product description with complete technical data, performance curves, and product specification sheets.
 - 4. Installation instructions, including factors affecting performance.
- C. Sustainable Design Submittals:
 - 1. [Product data showing compliance with](#) ASHRAE 62.1.
- D. Shop Drawings:
 - 1. Include plans, elevations, sections, and mounting details.
 - 2. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include diagrams for power, signal, and control wiring.
 - 4. Include diagrams for air and process signal tubing.
 - 5. Number-coded identification system for unique identification of wiring, cable, and tubing ends.

1.5 INFORMATIONAL SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 “Submittal Procedures” and the individual sections specifying the work.
- B. Product Certificates: For each product requiring a certificate.
- C. Product Test Reports: For each product, for tests performed by manufacturer and witnessed by a qualified testing agency.

1.6 CLOSEOUT SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 “Submittal Procedures” and the individual sections specifying the work.
- B. Operation and Maintenance Data: For instruments to include in operation and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 “Submittal Procedures” and the individual sections specifying the work.
- B. Furnish extra materials and parts that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
- C. Provide parts, as indicated by manufacturer's recommended parts list, for product operation during two-year period following warranty period.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 GENERAL REQUIREMENTS FOR FLOW INSTRUMENTS

- A. Air sensors and transmitters shall have an extended range of 20 percent above Project design flow and 20 percent below minimum Project flow to signal abnormal flow conditions and to provide flexibility for changes in operation.
- B. Liquid sensors, meters, and transmitters shall have an extended range of 20 percent above Project design flow and 10 percent below Project minimum flow to signal abnormal flow conditions and to provide flexibility for changes in operation.

2.3 AIRFLOW SENSORS:

- A. Performance Requirements:
 - 1. Adjustable for changes in system operational parameters.
 - 2. Airflow Sensor and Transmitter Range: Extended range of 20 percent above Project design flow and 20 percent below minimum Project flow to signal abnormal flow conditions.
 - 3. Manufacturer shall certify that each flow instrument indicated complies with specified performance requirements and characteristics.

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- a. Product certificates are required.

B. Pitot-Tube Airflow Sensor Station:

1. Description: Multiple total- and static-pressure sensors positioned at the center of equal area of the station cross section and interconnected by respective averaging manifolds.
 - a. Stations 4 sq. ft. and Smaller: One total-pressure sensor and one static-pressure sensor for every 16 sq. in. of station area.
 - b. Stations Larger than 4 sq. ft.: One total-pressure sensor and one static-pressure sensor for every 36 sq. in. of station area.
2. Casing: Galvanized sheet steel at least 0.079 inch thick with coating complying with ASTM A 653/A 653M, G90. Casings shall be stainless steel, 0.0781 inch thick, when connected to stainless duct and aluminum, 0.063 inch thick, when connected to aluminum duct.
 - a. Joints and Seams: Continuously weld. Clean galvanized areas damaged by welding and coat with aluminum paint.
 - b. Casing Depth: At least 8 inches.
 - c. Casing Flanges: Outward flange, minimum flange face 1.5 inches.
 - d. Casing Configuration and Size: Match shape (rectangular, round, flat oval) and same size as adjacent duct unless otherwise indicated.
3. Include an open parallel cell air straightener or air equalizer honeycomb mechanically fastened to casing.
 - a. Construct straightener or equalizer from Type 3003 aluminum or Type 316 stainless steel, depending on casing material. Use stainless steel for units with stainless-steel casings.
4. Construct pressure sensor array from drawn copper or stainless-steel tubing. Use stainless steel for units with stainless-steel casings. Copper tubing shall comply with ASTM B 75 and ASTM B 280. Minimum tube wall thickness shall be 0.030 inch. Include internal piping and external pressure transmitter ports.
5. Station Labeling: Identification label on each station casing indicating model number, size, area, and application-specific airflow range.
6. Performance:
 - a. Pressure Loss: 0.015-inch wg at 1000 fpm, or 0.085-inch wg at 2000 fpm.
 - b. Accuracy: Within 2 percent of actual airflow.
 - c. Self-Generated Sound: NC 40 and sound level within the duct shall not be amplified.
 - d. Performance rated and tested according to AMCA 610. Each station shall bear the AMCA seal.

C. Pitot-Tube Fan Inlet Airflow Traverse Sensor:

1. Traverse manifold designed for mounting in fan inlets.

2. Contain multiple total- and static-pressure sensors placed at concentric area centers along the exterior surface of cylindrical manifold and internally connected to their respective averaging manifolds. Sensors shall not protrude beyond the surface of the manifold nor be adversely affected by particle contamination present in airstream.
3. Manifold (two per inlet) shall have dual end support swivel brackets suitable for mounting in the fan inlet bell and symmetrical averaging signal takeoffs and fittings.
4. Sensors shall be capable of producing steady, non-pulsating signals of standard total- and static-pressure without need for flow corrections or factors, with an accuracy of 3 percent of actual flow over a turndown range of 6 to 1.
5. Manifold Materials: Copper or anodized aluminum or Type 316 stainless steel.
6. Unless otherwise required by application and without affecting the fan and sensor performance, nominal diameter copper and aluminum manifolds shall be the following:
 - a. For Fan Inlets Smaller than 20 Inches: 0.375 inch.
 - b. For Fan Inlets 20 Inches and Larger: 0.75 inch.
7. Unless otherwise required by application and without affecting the fan and sensor performance, nominal diameter stainless-steel manifolds shall be the following:
 - a. For Fan Inlets Smaller than 20 Inches: 0.375 inch.
 - b. For Fan Inlets 20 through 48 Inches: 0.75 inch.
 - c. For Fan Inlets Larger than 48 Inches: 1.0 inch.

D. Piezometer Ring Fan Inlet Airflow Sensor:

1. In lieu of externally mounted fan inlet airflow sensors, option to provide fans with airflow measurement integral to fan inlet cones for continuous measurement of air volume flow rate.
2. Multiple pressure sensor points strategically placed along the circumference of the inlet cone and internally connected to an averaging ring manifold located behind the inlet cone.
3. Sensor points shall not protrude beyond the surface of the inlet cone nor be adversely affected by particle contamination present in the airstream.
4. Sensor shall produce steady, non-pulsating signals to achieve accuracy within 5 percent of actual airflow.
5. Sensor shall be non-intrusive and not impact fan performance.
6. Product shall be a standard offering of the fan manufacturer and include published literature with supporting test data to validate sensor performance.

E. Thermal Airflow Station:

1. Source Limitations: Obtain airflow and temperature measuring sensors and transmitters from single manufacturer.
2. Description: Airflow station shall consist of one or more sensor probes mounted in a casing, and a remotely mounted microprocessor-based transmitter.
3. Performance:
 - a. Capable of independently processing up to 16 independently wired sensor assemblies.

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- b. Airflow rate of each sensor assembly shall be equally weighted and averaged by transmitter prior to output.
 - c. Temperature of each sensor assembly shall be velocity weighted and averaged by transmitter prior to output.
 - d. Listed and labeled by an NRTL as successfully tested as an assembly according to UL 873, "Temperature-Indicating and Regulating Equipment."
 - e. Components shall be interconnected by exposed NRTL-listed plenum-rated cable or non-listed cable placed in conduit.
 - f. Each flow station shall be factory calibrated at a minimum of 16 airflow rates and three temperatures to standards that are traceable to NIST.
 - g. Airflow Accuracy: Within 3 percent of reading over the entire operating airflow range.
 - 1) Devices whose accuracy is combined accuracy of transmitter and sensor probes must demonstrate that total accuracy meets the performance requirements throughout the measurement range.
 - h. Temperature Accuracy: Within 0.2 deg F over entire operating range of minus 20 to plus 140 deg F.
 - i. Sensor Ambient Operating Temperature Range: Minus 20 to plus 160 deg F.
 - j. Transmitter Ambient Operating Temperature Range: Minus 20 to plus 120 deg F.
 - k. Sensor and Transmitter Ambient Operating Humidity Range: Zero to 99 percent, non-condensing.
 - l. Instrument shall compensate for changes in air temperature and density throughout calibrated velocity range for seasonal extremes at Project location.
 - m. Pressure Drop: 0.05-inch wg at 2000 fpm across a 24-by-24-inch area.
 - n. Instruments mounted in throat or face of fan inlet cone shall not negatively influence fan performance by reducing flow more than 1 percent of Project design flow or negatively impact fan-generated sound. Losses in performance shall be documented with submittal data, and adjustments to compensate for performance impact shall be made to fan in order to deliver Project design airflow indicated.
4. Sensor Assemblies:
- a. Each sensor probe shall contain two individually wired, hermetically sealed bead-in-glass thermistors.
 - b. Mount thermistors in sensor using a marine-grade, waterproof epoxy.
 - c. Thermistor leads shall be protected and not exposed to the environment.
 - d. Each sensor assembly shall independently determine airflow rate and temperature at each measurement point.
 - e. Each sensor probe shall have an integral cable for connection to remotely mounted transmitter.
 - f. Sensor Probe Material: Gold anodized, extruded 6063 aluminum tube or Type 304 stainless steel.
 - g. Probe Assembly Mounting Brackets Material: Type 304 stainless steel.
5. Casing:
- a. Factory mount sensor probes in an airflow station casing to create a single assembly for field mounting.

- b. Material: Galvanized sheet steel at least 0.079 inch thick with coating complying with ASTM A 653/A 653M, G90. Casings shall be stainless steel, 0.0781 inch thick, when connected to stainless duct and aluminum, 0.063 inch thick, when connected to aluminum duct.
 - c. Joints and Seams: Continuously weld. Clean galvanized areas damaged by welding and coat with zinc-rich paint.
 - d. Casing Depth: At least 8 inches.
 - e. Include casing inlet and discharge connections with a minimum 1.5-inch face flange.
6. Transmitter:
- a. Integral digital display capable of simultaneously displaying total airflow and average temperature, individual airflow, and temperature readings of each independent sensor assembly.
 - b. Capable of field configuration and diagnostics using an onboard push-button interface and digital display.
 - 1) Include an integral power switch to operate on 24-V ac (isolation not required) and include the following:
 - a) Integral protection from transients and power surges.
 - b) Circuitry to ensure reset after power disruption, transients, and brownouts.
 - c) Integral transformer to convert field power source to operating voltage required by instrument.
 - c. Remote Signal Interface:
 - 1) Linear Analog Signals for Airflow and Temperature: Fuse protected and isolated, field selectable, zero- to 10-V dc or 4 to 20 mA.
 - 2) RS-485: BACnet-ARCNET, BACnet-MS/TP, and Modbus-RTU.
 - 3) 10 Base-T Ethernet: BACnet Ethernet, BACnet-IP, Modbus-TCP, and TCP/IP.
 - 4) LonWorks free topology.

2.4 AIRFLOW TRANSMITTERS

A. Airflow Transmitter with 0.10 Percent Accuracy and Auto-Zero Feature:

- 1. Transmitter shall receive total- and static-pressure signals from a primary element, amplify signals, extract the square root, and scale the signals to produce 4- to 20-mA dc output signals linear to airflow.
- 2. NEMA 250, Type 1 enclosure.
- 3. Construct assembly so that shock, vibration, and pressures surges of up to 1 psig will neither harm transmitter, nor affect its accuracy.
- 4. Transmitter with automatic zeroing circuit capable of automatically readjusting transmitter zero at predetermined time intervals. The automatic zeroing circuit shall re-zero transmitter to within 0.1 percent of true zero.

5. Performance:
 - a. Range: As required by application and at least 10 percent below minimum airflow and 10 percent greater than design airflow.
 - b. Calibrated Span: Field adjustable, minus 40 percent of the range.
 - c. Accuracy: Within 0.10 percent of natural span.
 - d. Repeatability: Within 0.15 percent of calibrated span.
 - e. Linearity: Within 0.2 percent of calibrated span.
 - f. Hysteresis and Deadband (Combined): Less than 0.2 percent of calibrated span.
 6. Integral digital LED or digital display for continuous indication of airflow.
- B. Airflow Transmitters with 0.25 Percent Accuracy and Auto-Zero Feature:
1. Transmitter shall receive total- and static-pressure signals from a flow element, amplify signals, extract the square root, and scale the signals to produce 4- to 20-mA dc output signals linear to airflow.
 2. NEMA 250, Type 1 enclosure.
 3. Construct assembly so shock, vibration, and pressure surges of up to 1 psig will neither harm transmitter, nor affect its accuracy.
 4. Transmitter with automatic zeroing circuit capable of automatically readjusting transmitter zero at predetermined time intervals. The automatic zeroing circuit shall re-zero the transmitter to within 0.1 percent of true zero.
 5. Performance:
 - a. Range: As required by application and at least 10 percent below minimum airflow and 10 percent greater than design airflow.
 - b. Calibrated Span: Field adjustable, minus 40 percent of the range.
 - c. Accuracy: Within 0.25 percent of natural span.
 - d. Repeatability: Within 0.15 percent of calibrated span.
 - e. Linearity: Within 0.2 percent of calibrated span.
 - f. Hysteresis and Deadband (Combined): Less than 0.2 percent of calibrated span.
 6. Integral digital display for continuous indication of airflow.
- C. Pressure Differential Transmitters for Airflow Measurement:
1. Performance:
 - a. Range: As required by application and at least 10 percent below minimum airflow and 10 percent greater than design airflow.
 - b. Accuracy: Within 1 percent of the full-scale range.
 - c. Hysteresis: Within 0.10 percent of full scale.
 - d. Repeatability: Within 0.05 percent of full scale.
 - e. Stability: Within one percent of span per year.
 - f. Overpressure: 10 psig.
 - g. Temperature Limits: Zero to 150 deg F.
 - h. Compensate Temperature Limits: 40 to 150 deg F.
 - i. Thermal Effects: 0.033 percent of full scale per degree F.
 - j. Shock and vibration shall not harm the transmitter.

2. Output Signals:
 - a. Analog Current Signal:
 - 1) Two-wire, 4- to 20-mA dc current source.
 - 2) Signal capable of operating into 800-ohm load.
 - b. Analog Voltage Signal:
 - 1) Three wire, zero to 10 V.
 - 2) Minimum Load Resistance: 1000 ohms.
3. Display: Four-digit digital with minimum 0.4-inch-high numeric characters.
4. Operator Interface:
 - a. Zero and span adjustments located behind cover.
5. Construction:
 - a. Plastic casing with removable plastic cover.
 - b. Fittings: Swivel fittings for connection to copper tubing or barbed fittings for connection to polyethylene tubing. Fittings on bottom of instrument case.
 - c. Screw terminal block for wire connections.
 - d. Vertical plane mounting.
 - e. NEMA 250, Type 4.
 - f. Mounting Bracket: Appropriate for installation.

D. Pressure Differential Indicating Transmitter, Switch, and Controller for Airflow Measurement:

1. Description:
 - a. Three-in-one instrument, including digital display, control relay switches, and a transmitter with a current output.
 - b. Field configurable for pressure, velocity, and volumetric flow applications through user interface.
 - c. Select instrument range based on application.
2. Performance:
 - a. Accuracy including hysteresis and repeatability:
 - 1) Ranges Less than 5-Inch wg: Within 1 percent.
 - 2) Other Ranges: Within 0.5 percent at 77 deg F.
 - b. Stability: Within 1 percent per year.
 - c. Response Time: 250 ms.
 - d. Overpressure:
 - 1) Ranges Less than 50-Inch wg: 5 psi
 - 2) Range of 100-Inch wg: 9 psi.

- e. Temperature Limits: 32 to 140 deg F.
 - f. Thermal Effects: 0.020 percent per deg F.
 - g. Warm-up Period: One hour.
3. Controller: Programming through menu keys to access five menus.
- a. Security level.
 - b. Pressure, velocity, or flow application.
 - c. Engineering units.
 - d. K-factor for use with flow application.
 - e. Set-point control only; set-point and alarm operation; alarm operation as high, low, or high/low with manual; or automatic reset and delay.
 - f. View high and low readings.
 - g. Digital dampening for smoothing erratic applications.
 - h. Scaling of analog output to fit range and field calibration.
4. Display:
- a. Four-digit digital, with minimum 0.4-inch-high alphanumeric characters.
 - b. Four LED indicators; two LEDs for set point and two LEDs for alarm status.
5. Operator Interface:
- a. Set-point adjustment through keypad on face of instrument.
 - b. Zero and span adjustments accessible through menu.
 - c. Programming through keypad.
6. Output Analog Signal: Two-wire, 4- to 20-mA dc current source; capable of operating into a 900-ohm load.
7. Output Digital Signal: Two, SPDT relays; each rated for 1 A at 30-V ac or 30-V dc.
8. Construction:
- a. Die-cast aluminum casing and bezel.
 - b. Connections on side and back.
 - c. Vertical plane mounting.
 - d. NEMA 250, Type 1 rating.
 - e. Nominal 4-inch-diameter face.
 - f. Mounting Bracket: Appropriate for installation.

2.5 LIQUID FLOW SWITCHES

A. Liquid Flow Switch (Magnetic Type):

1. Description:
- a. Field-adjustable five-vane combinations.
 - b. Suitable for pipe sizes NPS 1-1/2 through NPS 20.
 - c. Mounting Suitable for Application: Switch vertically mounted in horizontal pipe, or switch horizontally mounted in vertical pipe with flow up.

- d. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for hazardous-environment Class I, Groups C and D; Class II, Groups E, F, and G.
2. Performance:
 - a. Flow Rate Actuation and De-actuation: Varies with vane combination.
 - b. Pressure Limit: 1000 psig for brass body, 2000 psig for Type 316 stainless-steel body.
 - c. Temperature Range: Minus 4 to plus 275 deg F.
 - d. Electrical Rating: 10 A at 125/250-V ac.
 3. Wetted Parts Construction:
 - a. Vanes: Type 316 stainless steel.
 - b. Body: Brass.
 - c. Magnetic Keeper: Type 316 or 430 stainless steel.
 - d. Process Connection: NPS 1-1/2.
 4. Enclosure:
 - a. Die-cast aluminum alloy.
 - b. Threaded cover.
 - c. NEMA 250, Type 4.
 - d. Electrical Connection: Terminal block.
 - e. Conduit Connection: trade size.
- B. Liquid Flow Switch (Magnetic Type) for Small-Diameter Pipe:
1. Description:
 - a. Suitable for pipe sizes NPS 1/2 through NPS 2.
 - b. Mounting Suitable for Application: Switch vertically mounted in horizontal pipe, or switch horizontally mounted in vertical pipe with flow up.
 - c. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for hazardous-environment Class I, Groups A, B, C, and D; Class II, Groups E, F, and G.
 2. Performance:
 - a. Flow Rate Actuation and De-actuation: Not adjustable.
 - b. Pressure Limit of Body: 1000 psig for brass, 2000 psig for Type 303 stainless-steel body.
 - c. Pressure Limit of Tee: 250 psig for brass, 1000 psig for malleable iron, and 2000 psig for forged carbon steel and stainless steel.
 - d. Temperature Range: Minus 4 to plus 220 deg F.
 - e. Electrical Rating: 5 A at 125/250-V ac.
 3. Wetted Parts Construction (Lower Body):

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- a. Vanes: Type 301 stainless steel.
 - b. Body: Brass.
 - c. Magnet: Ceramic.
 - d. Process Connection: NPS 1/2.
4. Enclosure (Upper Body):
- a. Brass.
 - b. NEMA 250, Type 4.
 - c. Electrical Connection: Terminal block.
 - d. Conduit Connection: 3/4-inch trade size.
5. Integral Mounting Tee Furnished with Switch:
- a. Brass.
 - b. Size: Match adjacent pipe.
 - c. Connection: Threaded pipe.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for instruments installed in piping to verify actual locations of connections before installation.
- C. Examine roughing-in for instruments installed in duct systems to verify actual locations of connections before installation.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTRUMENT APPLICATIONS

- A. Select from instrument types to achieve performance requirements and characteristics indicated while subjected to full range of system operation encountered.
- B. Duct-Mounted Airflow Sensors:
 1. Measured Velocities 500 fpm and Less: Thermal airflow station.
 2. Measured Velocities Greater than 500 fpm: Pitot-tube airflow sensor station or thermal airflow station.

3.3 INSTALLATION, GENERAL

- A. Furnish and install products required to satisfy more stringent of all requirements indicated.

- B. Install products level, plumb, parallel, and perpendicular with building construction.
- C. Properly support instruments, tubing, piping, wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment when subjected to a force.
- D. Install ceiling, floor, roof, and wall openings and sleeves required by installation. Before proceeding with drilling, punching, or cutting, check location first for concealed products that could potentially be damaged. Patch, flash, grout, seal, and refinish openings to match adjacent condition.
- E. Install products in locations that are accessible and that will permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

3.4 ELECTRIC POWER

- A. Furnish and install electrical power to products requiring electrical connections.
- B. Furnish and install circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."
- C. Furnish and install power wiring. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- D. Furnish and install raceways. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems."

3.5 INSTRUMENTS, GENERAL INSTALLATION REQUIREMENTS

- A. Mounting Location:
 - 1. Rough-in: Outline instrument-mounting locations before setting instruments and routing cable, wiring, tubing, and conduit to final location.
 - 2. Install switches and transmitters for air and liquid flow associated with individual air-handling units and connected ductwork and piping near air-handlings units co-located in air-handling unit system control panel, to provide service personnel a single and convenient location for inspection and service.
 - 3. Install liquid flow switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.
 - 4. Install airflow switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.
 - 5. Mount switches and transmitters not required to be mounted within system control panels on walls, floor-supported freestanding pipe stands, or floor-supported structural support frames. Use manufacturer mounting brackets to accommodate field mounting. Securely support and brace products to prevent vibration and movement.

6. Install instruments in liquid and liquid-sealed-piped services below their process connection point. Slope tubing down to instrument with a slope of 2 percent.

3.6 FLOW INSTRUMENTS INSTALLATION

A. Airflow Sensors:

1. Install sensors in straight sections of duct with manufacturer-recommended straight duct upstream and downstream of sensor.
2. Installed sensors shall be accessible for visual inspection and service. Install access door(s) in duct or equipment located upstream of sensor, to allow service personnel to hand clean sensors.

B. Liquid and Steam Sensors:

1. Install sensors in straight sections of piping with manufacturer-recommended straight piping upstream and downstream of sensor.
2. Alert manufacturer where installation cannot accommodate recommended clearance, and solicit recommendations for field modifications to installation, such as flow straighteners, to improve condition.
3. Install pipe reducers for in-line sensors smaller than line size. Position reducers at distance from sensor to avoid interference and impact on accuracy.
4. Install in-line sensors with flanges or unions to provide drop-in and -out installation.

C. Liquid Flow Meters:

1. Install meters in straight sections of piping with manufacturer-recommended straight piping upstream and downstream of sensor.
2. Install pipe reducers for in-line meters smaller than line size. Install reducers at distance from meter to avoid interference and impact on accuracy.
3. Install in-line meters with flanges or unions to provide drop-in and -out installation.
4. Insertion Meters:
 - a. Install meter in top dead center of horizontal pipe positioned in an accessible location to allow for inspection and replacement.
 - b. In applications where top-dead-center location is not possible due to field constraints, install meter at location along top half of pipe if acceptable by manufacturer for mounting orientation.

D. Liquid Switches:

1. Install switch in top dead center of horizontal pipe positioned in an accessible location to allow for inspection and replacement.
2. In applications where top-dead-center location is not possible due to field constraints, install switch at location along top half of pipe if switch is acceptable by manufacturer for mounting orientation.

E. Transmitters:

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1. Install airflow transmitters serving an air system in a single location adjacent to or within system control panel.
2. Install liquid flow transmitters, not integral to sensors, in vicinity of sensor. Where multiple flow transmitters serving same system are located in same room, co-locate transmitters by system to provide service personnel a single and convenient location for inspection and service.

3.7 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing shall have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Install engraved phenolic nameplate with instrument identification.

3.8 CLEANING

- A. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from exposed interior and exterior surfaces.
- B. Wash and shine glazing.
- C. Polish glossy surfaces to a clean shine.

3.9 CHECKOUT PROCEDURES

- A. Description:
 1. Check out installed products before continuity tests, leak tests, and calibration.
 2. Check instruments for proper location and accessibility.
 3. Check instruments for proper installation with respect to direction of flow, elevation, orientation, insertion depth, or other applicable considerations that will impact performance.
 4. Check instrument tubing for proper isolation, fittings, slope, dirt legs, drains, material, and support.
- B. Flow Instrument Checkout:
 1. Verify that sensors are installed correctly with respect to flow direction.
 2. Verify that sensor attachment is properly secured and sealed.
 3. Verify that processing tubing attachment is secure and isolation valves have been provided.
 4. Inspect instrument tag against approved submittal.
 5. Verify that recommended upstream and downstream distances have been maintained.

3.10 ADJUSTMENT, CALIBRATION, AND TESTING

A. Description:

1. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.
2. Provide a written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.
3. For each analog instrument, make a three-point test of calibration for both linearity and accuracy.
4. Equipment and procedures used for calibration shall meet instrument manufacturer's recommendations.
5. Provide diagnostic and test equipment for calibration and adjustment.
6. Field instruments and equipment used to test and calibrate installed instruments shall have accuracy at least twice the instrument accuracy being calibrated. For example, an installed instrument with an accuracy of 1 percent shall be checked by an instrument with an accuracy of 0.5 percent.
7. Calibrate each instrument according to instrument instruction manual supplied by manufacturer.
8. If after-calibration-indicated performance cannot be achieved, replace out-of-tolerance instruments.
9. Comply with field-testing requirements and procedures indicated by ASHRAE Guideline 11, "Field Testing of HVAC Control Components," in the absence of specific requirements, and to supplement requirements indicated.

B. Analog Signals:

1. Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.
2. Check analog current signals using a precision current meter at zero, 50, and 100 percent.
3. Check resistance signals for temperature sensors at zero, 50, and 100 percent of operating span using a precision-resistant source.

C. Digital Signals:

1. Check digital signals using a jumper wire.
2. Check digital signals using an ohmmeter to test for contact.

D. Sensors: Check sensors at zero, 50, and 100 percent of Project design values.

E. Switches: Calibrate switches to make or break contact at set points indicated.

F. Transmitters:

1. Check and calibrate transmitters at zero, 50, and 100 percent of Project design values.
2. Calibrate resistance temperature transmitters at zero, 50, and 100 percent of span using a precision-resistance source.

3.11 MAINTENANCE SERVICE

- A. Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 24 months' full maintenance by manufacturer's authorized service representative. Include annual preventive maintenance, repair or replacement of worn or defective components, cleaning, and adjusting as required for proper operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

3.12 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain instrumentation and control devices.
- B. Coordinate video with operation and maintenance manuals and classroom instruction for use by Owner in operating, maintaining, and troubleshooting.
- C. Record videos on DVD disks.
- D. Owner shall have right to make additional copies of video for internal use without paying royalties.

END OF SECTION

SECTION 230923.16 - GAS INSTRUMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes the Following Gas Instruments:
 - 1. Carbon-dioxide sensors and transmitters.
- B. Related Requirements:
 - 1. Section 230923 "Direct-Digital Control System for HVAC" for control equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, and cable.
- C. Sustainable Design Requirements: Work included in this specification shall conform to the US Green Building Council LEED requirements listed in Section 018113.23 "Sustainable Design Requirements - LEED 2009 for Schools."

1.3 DEFINITIONS

- A. NDIR: Nondispersive infrared.

1.4 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of the Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.
- C. Product Data: For each type of product, including the following:
 - 1. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
 - 2. Installation instructions, including factor affecting performance.

3. Product description with complete technical data, performance curves, product specification sheets.

D. Sustainable Design Submittals:

1. Product data showing compliance with ASHRAE 62.1.

E. Shop Drawings:

1. Include plans, elevations, sections, and mounting details.
2. Include diagrams for power, signal, and control wiring.
3. Number-coded identification system for unique identification of wiring, cable, and tubing ends.

1.5 INFORMATIONAL SUBMITTALS

- A. Submittals shall comply with the requirements of the Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Coordination Drawings: Plan drawings and corresponding product installation details, drawn to scale, on which wall-mounted instruments located in finished space are shown and coordinated with each other, showing relationship to light switches, fire alarm devices, and other installed devices using input from installers of the items involved.
- C. Product Test Reports: For each product, for tests performed by manufacturer and witnessed by a qualified testing agency or a qualified testing agency.

1.6 CLOSEOUT SUBMITTALS

- A. Submittals shall comply with the requirements of the Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.
- C. Operation and Maintenance Data: For gas instruments to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 CARBON-DIOXIDE SENSORS AND TRANSMITTERS

A. Description:

1. NDIR technology or equivalent technology providing long-term stability and reliability.
2. Two-wire, 4-20 mA output signal, linearized to carbon-dioxide concentration in ppm.

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- B. Construction:
 - 1. House electronics in an ABS plastic enclosure. Provide equivalent of NEMA 250, Type 1 enclosure for wall-mounted space applications and NEMA 250, Type 4 for duct-mounted applications.
 - 2. Equip with digital display for continuous indication of carbon-dioxide concentration.
- C. Performance:
 - 1. Measurement Range: Zero to 2000 ppm.
 - 2. Accuracy: Within 2 percent of reading, plus or minus 30 ppm.
 - 3. Repeatability: Within 1 percent of full scale.
 - 4. Temperature Dependence: Within 0.05 percent of full scale over an operating range of 25 to 110 deg F.
 - 5. Long-Term Stability: Within 5 percent of full scale after more than five years.
 - 6. Response Time: Within 60 seconds.
 - 7. Warm-up Time: Within five minutes.
- D. Provide calibration kit. Turn over to Owner at start of warranty period.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for instruments installed in piping to verify actual locations of connections before installation.
- C. Examine roughing-in for instruments installed in duct systems to verify actual locations of connections before installation.
- D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Furnish and install products required to satisfy more stringent of all requirements indicated.
- B. Install products level, plumb, parallel, and perpendicular with building construction.
- C. Fastening Hardware:
 - 1. Stillson wrenches, pliers, and other tools that cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening nuts.

2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by using excessive force or oversized wrenches.
 3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.
- D. Install products in locations that are accessible and that permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

3.3 ELECTRICAL POWER

- A. Furnish and install electrical power to products requiring electrical connections.
- B. Furnish and install circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."
- C. Furnish and install power wiring. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- D. Furnish and install raceways. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems."

3.4 INSTRUMENTS, GENERAL INSTALLATION REQUIREMENTS

- A. Mounting Height:
 1. Mount instruments in user-occupied space to match mounting height of light switches unless otherwise indicated on Drawings. Mounting height shall comply with codes and accessibility requirements.
- B. Seal penetrations to ductwork, plenums, and air-moving equipment to comply with duct static-pressure class and leakage and seal classes indicated, using neoprene gaskets or grommets.

3.5 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing shall have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Install engraved nameplate with instrument identification on face.

3.6 CHECKOUT PROCEDURES

- A. Check out installed products before continuity tests, leak tests, and calibration.
- B. Check instruments for proper location and accessibility.

- C. Check instruments for proper installation on elevation, orientation, insertion depth, or other applicable considerations that impact performance.
- D. Check instrument tubing for proper isolation, fittings, slope, dirt legs, drains, material, and support.

3.7 ADJUSTMENT, CALIBRATION, AND TESTING

A. Description:

1. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.
2. Provide a written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.
3. For each analog instrument, perform a three-point calibration test for both linearity and accuracy.
4. Equipment and procedures used for calibration shall comply with instrument manufacturer's written recommendations.
5. Provide diagnostic and test equipment for calibration and adjustment.
6. Field instruments and equipment used to test and calibrate installed instruments shall have an accuracy of at least twice the instrument accuracy being calibrated. For example, an installed instrument with an accuracy of 1 percent shall be checked by an instrument with an accuracy of 0.5 percent.
7. Calibrate each instrument according to instrument instruction manual supplied by manufacturer.
8. If, after calibration, indicated performance cannot be achieved, replace out-of-tolerance instruments.
9. Comply with field-testing requirements and procedures in ASHRAE Guideline 11, "Field Testing of HVAC Control Components," in the absence of specific requirements, and to supplement requirements indicated.

B. Analog Signals:

1. Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.
2. Check analog current signals using a precision current meter at zero, 50, and 100 percent.
3. Check resistance signals for temperature sensors at zero, 50, and 100 percent of operating span using a precision-resistant source.

C. Digital Signals:

1. Check digital signals using a jumper wire.
2. Check digital signals using an ohmmeter to test for contact.

D. Sensors: Check sensors at zero, 50, and 100 percent of Project design values.

E. Switches: Calibrate switches to make or break contact at set points indicated.

F. Transmitters:

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1. Check and calibrate transmitters at zero, 50, and 100 percent of Project design values.
2. Calibrate resistance temperature transmitters at zero, 50, and 100 percent of span using a precision-resistance source.

3.8 MAINTENANCE SERVICE

- A. Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by manufacturer's authorized service representative. Include quarterly preventive maintenance, repair or replacement of worn or defective components, cleaning, and adjusting as required for proper operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

3.9 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain instrumentation and control devices.
- B. Coordinate gas instrument demonstration video with operation and maintenance manuals and classroom instruction for use by Owner in operating, maintaining, and troubleshooting.
- C. Record videos on DVD disks.
- D. Owner shall have right to make additional copies of video for internal use without paying royalties.

END OF SECTION

SECTION 230923.19 - MOISTURE INSTRUMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes moisture switches, sensors, and transmitters.
- B. Related Requirements:
 - 1. Section 230923 "Direct-Digital Control System for HVAC" for control equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, and cable.

1.3 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of the Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.
- C. Product Data: For each type of product, including the following:
 - 1. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
 - 2. Product description with complete technical data, performance curves, and product specification sheets.
- D. Shop Drawings:
 - 1. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Include diagrams for power, signal, and control wiring.
 - 3. Include number-coded identification system for unique identification of wiring, cable, and tubing ends.

1.4 CLOSEOUT SUBMITTALS

- A. Submittals shall comply with the requirements of the Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.
- C. Operation and Maintenance Data: To include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 MOISTURE SENSORS AND TRANSMITTERS

- A. Sensor and Transmitter without Display:
 - 1. Performance:
 - a. Accuracy including non-linearity, hysteresis, and repeatability: Within 2 percent from zero to 90 percent relative humidity and within 3 percent from 90 to 95 percent relative humidity when operating at 68 deg F.
 - b. Relative Humidity Range:
 - 1) Duct: Zero to 100 percent.
 - 2) Space: Zero to 95 percent relative.
 - c. Factory calibrated and NIST traceable with certificate included.
 - 2. Construction for Space Applications:
 - a. Housing with integral sensor.
 - b. Housing shall be ABS plastic or powder-coated aluminum.
 - c. Enclosure: NEMA 250, Type 4.
 - d. Provide housing with a wall-mounting plate.
 - 3. Construction for Duct and Equipment Applications:
 - a. Housing with integral sensor.
 - b. Duct Sensor Body: 300 series stainless steel.
 - c. Provide sensor with sintered stainless-steel filter for duct applications.
 - d. Housing shall be cast aluminum.
 - e. Enclosure: NEMA 250, Type 4.
 - 4. Output Signal: Two-wire, 4- to 20-mA output signal with drive capacity of at least 500 ohms at 24-V dc.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for instruments installed in duct systems to verify actual locations of connections before installation.
- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Install products level, plumb, parallel, and perpendicular with building construction.
- B. Properly support instruments, wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment when subjected to a force.
- C. Fastening Hardware:
 - 1. Stillson wrenches, pliers, and other tools that cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening nuts.
 - 2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
- D. Install products in locations that are accessible and that permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

3.3 ELECTRIC POWER

- A. Furnish and install electrical power to products requiring electrical connections.
- B. Furnish and install circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."
- C. Furnish and install power wiring. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- D. Furnish and install raceways. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems."

3.4 MOISTURE INSTRUMENTS INSTALLATION

- A. Mounting Location: Rough-in instrument-mounting locations before setting instruments and routing, cable, wiring, tubing, and conduit to final location.
- B. Mounting Height:
 - 1. Mount instruments in user-occupied space to match mounting height of light switches unless otherwise indicated on Drawings. Mounting height shall comply with codes and accessibility requirements.
 - 2. Mount switches and transmitters located in mechanical equipment rooms and other similar space not subject to code, state, and Federal accessibility requirements within a range of 42 to 72 inches above the adjacent floor, grade, or service catwalk or platform.
 - a. Make every effort to mount at 60 inches.

3.5 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing shall have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section "Identification for Electrical Systems."
- B. Install engraved nameplate with instrument identification on face of ceiling directly below instruments concealed above ceilings.

3.6 CHECKOUT PROCEDURES

- A. Check installed products before continuity tests and calibration.
- B. Check instruments for proper location and accessibility.
- C. Check instruments for proper installation on direction of flow, elevation, orientation, insertion depth, or other applicable considerations that impact performance.

3.7 ADJUSTMENT, CALIBRATION, AND TESTING

- A. Description:
 - 1. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.
 - 2. Provide a written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.
 - 3. For each analog instrument, make a three-point test of calibration for both linearity and accuracy.
 - 4. Equipment and procedures used for calibration shall meet instrument manufacturer's written instructions.

5. Provide diagnostic and test equipment for calibration and adjustment.
6. Field instruments and equipment used to test and calibrate installed instruments shall have accuracy at least twice the instrument accuracy being calibrated. For example, an installed instrument with an accuracy of 1 percent shall be checked by an instrument with an accuracy of 0.5 percent.
7. Calibrate each instrument according to instrument instruction manual supplied by manufacturer.
8. If after calibration indicated performance cannot be achieved, replace out-of-tolerance instruments.
9. Comply with field-testing requirements and procedures indicated by ASHRAE Guideline 11, "Field Testing of HVAC Control Components," in the absence of specific requirements, and to supplement requirements indicated.

B. Analog Signals:

1. Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.
2. Check analog current signals using a precision current meter at zero, 50, and 100 percent.
3. Check resistance signals for temperature sensors at zero, 50, and 100 percent of operating span using a precision-resistance source.

C. Digital Signals:

1. Check digital signals using a jumper wire.
2. Check digital signals using an ohmmeter to test for contact.

D. Sensors: Check sensors at zero, 50, and 100 percent of Project design values.

E. Transmitters:

1. Check and calibrate transmitters at zero, 50, and 100 percent of Project design values.
2. Calibrate resistance temperature transmitters at zero, 50, and 100 percent of span using a precision-resistance source.

3.8 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain instrumentation and control devices.
- B. Coordinate video with operation and maintenance manuals and classroom instruction for use by Owner in operating, maintaining, and troubleshooting.
- C. Record videos on DVD disks.
- D. Owner shall have right to make additional copies of video for internal use without paying royalties.

END OF SECTION

SECTION 230923.23 - PRESSURE INSTRUMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Air-pressure sensors.
2. Air-pressure switches.
3. Air-pressure transmitters.
4. Liquid-pressure switches.
5. Liquid-pressure transmitters.

B. Related Requirements:

1. Section 230923 "Direct-Digital Control System for HVAC" for control equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, and cable.

1.3 DEFINITIONS

- A. HART: Highway addressable remote transducer protocol is the global standard for sending and receiving digital information across analog wires between smart devices and control or monitoring systems through bi-directional communication that provides data access between intelligent field instruments and host systems. A host can be any software application from technician's hand-held device or laptop to a control, asset management, safety, or other system using any control platform.

1.4 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of the Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.
- C. Product Data: For each type of product, including the following:

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1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Operating characteristics; electrical characteristics; and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
3. Product description with complete technical data, performance curves, and product specification sheets.
4. Installation instructions, including factors affecting performance.

D. Shop Drawings:

1. Include plans, elevations, sections, and mounting details.
2. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Number-coded identification system for unique identification of wiring, cable, and tubing ends.

1.5 INFORMATIONAL SUBMITTALS

- A. Submittals shall comply with the requirements of the Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Coordination Drawings: Plan drawings and corresponding product installation details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 1. Product installation location shown in relationship to room, duct, pipe, and equipment.
 2. Wall-mounted instruments located in finished space, showing relationship to light switches, fire alarm devices, and other installed devices.
 3. Size and location of wall access panels for instruments installed behind walls.
 4. Size and location of ceiling access panels for instruments installed in accessible ceilings.
- C. Product Certificates: For each product requiring a certificate.
- D. Product Test Reports: For each product requiring test performed by manufacturer and witnessed by a qualified testing agency or a qualified testing agency.
- E. Source quality-control reports.
- F. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Submittals shall comply with the requirements of the Section 013300 "Submittal Procedures" and the individual sections specifying the work.

- B. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.
- C. Operation and Maintenance Data: For instruments to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Environmental Conditions:

- 1. Instruments shall operate without performance degradation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified and encountered for installed location.
 - a. If instrument alone cannot comply with requirement, install instrument in a protective enclosure that is isolated and protected from conditions impacting performance. Enclosure shall be internally insulated, electrically heated, filtered, and ventilated as required by instrument and application.

2.2 AIR-PRESSURE SENSORS

A. Duct Traverse Static Pressure Sensor:

- 1. Sensor shall traverse the duct cross section and have at least one pickup point every 6 inches along length of sensor.
- 2. Construct sensor of 18-gage Type T6063-T5 extruded and anodized aluminum.
- 3. Sensor supported with threaded rod, sealing washer, and nut at one end and a mounting plate with gasket at other end.
- 4. Mounting plate with threaded, NPS 3/8 compression fitting for connection to tubing.
- 5. Accuracy within 1 percent of actual operating static pressure.
- 6. Dual offset static sensor design shall provide accurate sensing of duct static pressure in the presence of turbulent and rotational airflows with a maximum 30 degree yaw and pitch.
- 7. Suitable for velocities of 100 to 10000 fpm and temperatures of up to 200 deg F.
- 8. Sensor air resistance shall be less than 0.1 times the velocity pressure at probe-operating velocity.
- 9. Suitable for flat oval, rectangular, and round duct configurations.

B. Outdoor Static Pressure Sensor:

- 1. Sensor with no moving parts.
- 2. Operation not affected and impaired by rain and snow.
- 3. Sensing plates constructed of 0.1406-inch Type 316 stainless steel.
- 4. Accuracy within:

- a. 1 percent of the actual outdoor atmospheric pressure when subjected to varying horizontal radial wind velocities up to 40 mph.
- b. 2 percent of the actual outdoor atmospheric pressure while subjected to varying radial wind velocities up to 40 mph with approach angles up to 30 degrees to horizontal.
- c. 3 percent of the actual outdoor atmospheric pressure while subjected to varying radial wind velocities up to 40 mph with approach angles up to 60 degrees to horizontal.
- d. Threaded, NPS 2 connection.

C. Space Static Pressure Sensor for Wall Mounting:

1. Stainless-steel wall plate with perforated center arranged to sense space static pressure. Exposed surfaces are provided with brush finish.
2. Wall plate provided with screws and sized to fit standard single-gang electrical box.
3. Back of sensor plate fitted with multiple sensing ports, pressure impulse suppression chamber, airflow shielding, and 0.125-inch fitting for tubing connection.
4. Performance: Within 1 percent of actual room static pressure in vicinity of sensor while being subjected to an air velocity of 1000 fpm from a 360-degree radial source.

D. Space Static Pressure Sensor for Recessed Ceiling Mounting:

1. Stainless-steel round plate with perforated center arranged to sense space static pressure. Exposed surfaces provided with brush finish.
2. Sensor intended for flush mount on face of ceiling with pressure chamber recessed in ceiling plenum.
3. Back of sensor plate fitted with multiple sensing ports, pressure impulse suppression chamber, airflow shielding, and 0.125-inch fitting for concealed tubing connection.
4. Performance: Within 1 percent of actual room static pressure in vicinity of sensor while being subjected to an air velocity of 1000 fpm from a 360-degree radial source.

2.3 AIR-PRESSURE SWITCHES

A. Air-Pressure Differential Switch with Set-Point Indicator:

1. Diaphragm operated to actuate an SPDT snap switch.
2. Electrical Connections: Three-screw configuration, including one screw for common operation and two screws for field-selectable normally open or closed operation.
3. Enclosure Conduit Connection: Knock out or threaded connection.
4. User Interface: Screw-type set-point adjustment with enclosed set-point indicator and scale.
5. High and Low Process Connections: Threaded, NPS 1/8.
6. Enclosure:
 - a. Dry Indoor Installations: NEMA 250, Type 1.
 - b. Outdoor and Wet Indoor Installations: NEMA 250, Type 4.
 - c. Hazardous Environments: Explosion proof.
7. Operating Data:

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- a. Electrical Rating: 15 A at 120- to 480-V ac.
- b. Pressure Limits:
 - 1) Continuous: 10 psig.
 - 2) Surge: 25 psig.
- c. Temperature Limits: Minus 30 to 110 deg F.
- d. Operating Range: Approximately 2 times set point.
- e. Repeatability: Within 1 percent.
- f. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Air-Pressure Differential Indicating Switch:

- 1. Combination gage with low- and high-limit switches.
- 2. Nominal 4-inch-diameter analog indication with white dial face, graduated black markings, pointer to indicate measured value, and a separate adjustable pointer for each switch set point.
- 3. Switch zero and set-point adjustment screws or knobs on the dial face.
- 4. Each switch used as a safety limit shall have a manual reset button local to switch.
- 5. Switch Type: Each set point shall have two Form C relays, DPDT.
- 6. Electrical Connections: Screw terminals.
- 7. Enclosure Conduit Connection: NPS 3/4 threaded connection.
- 8. High and Low Process Connections: Threaded, NPS 1/8.
- 9. Enclosure:
 - a. Dry Indoor Installations: NEMA 250, Type 1.
 - b. Outdoor and Wet Indoor Installations: NEMA 250, Type 4.
 - c. Hazardous Environments: Explosion proof.
- 10. Operating Data:
 - a. Electrical Rating: 10 A at 120- to 240-V ac.
 - b. Pressure Limits: 25 psig.
 - c. Temperature Limits: 20 to 120 deg F.
 - d. Operating Range: Approximately twice normal operating range unless otherwise required for application.
 - e. Accuracy:
 - 1) 4 percent for ranges through 0.5 in. wg.
 - 2) 2 percent for ranges 1 in. wg and greater.
 - f. Repeatability: Within 1 percent of full scale.
 - g. Switch Deadband: One pointer width and within 1 percent of full scale for each switch set point.
 - h. Power Supply: 24 or 120-V ac, 50/60 Hz.
 - i. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.4 AIR-PRESSURE TRANSMITTERS

A. Air-Pressure Differential Transmitter:

1. Performance:

- a. Range: Approximately 2 times set point.
- b. Accuracy: Within 0.5 percent of the full-scale range.
- c. Hysteresis: Within 0.10 percent of full scale.
- d. Repeatability: Within 0.05 percent of full scale.
- e. Stability: Within 1 percent of span per year.
- f. Overpressure: 10 psig.
- g. Temperature Limits: Zero to 150 deg F.
- h. Compensate Temperature Limits: 40 to 150 deg F.
- i. Thermal Effects: 0.033 percent of full scale per degree F.
- j. Shock and vibration shall not harm the transmitter.

2. Output Signals:

a. Analog Current Signal:

- 1) Two-wire, 4- to 20-mA dc current source.
- 2) Signal capable of operating into 800-ohm load.

b. Analog Voltage Signal:

- 1) Three wire, zero to 5 or 10 V.
- 2) Minimum Load Resistance: 1000 ohms.

3. Display: Four-digit digital display with minimum 0.4-inch-high numeric characters.

4. Operator Interface: Zero and span adjustments located behind cover.

5. Construction:

- a. Plastic casing with removable plastic cover.
- b. Threaded, NPS 1/4 swivel fittings for connection to copper tubing or NPS 3/16 barbed fittings for connection to polyethylene tubing. Fittings on bottom of instrument case.
- c. Screw terminal block for wire connections.
- d. Vertical plane mounting.
- e. NEMA 250, Type 4.
- f. Provide mounting bracket suitable for installation.

2.5 LIQUID-PRESSURE SWITCHES

A. Liquid-Pressure Differential Switch with Set-Point Indicator:

1. Description:

- a. Brass or Type 316 stainless-steel double opposing bellows operate to actuate a SPDT snap switch.
- b. Electrical Connections: Screw terminal.
- c. Enclosure Conduit Connection: Knock out or threaded connection.
- d. User Interface: Thumbscrew set-point adjustment with enclosed set-point indicator and scale.
- e. High and Low Process Connections: Threaded, NPS 1/8.
- f. Enclosure:
 - 1) Dry Indoor Installations: NEMA 250, Type 1.
 - 2) Outdoor and Wet Indoor Installations: NEMA 250, Type 4.
 - 3) Hazardous Environments: Explosion proof.
- g. Operating Data:
 - 1) Electrical Rating: 15 A at 120- to 240-V ac.
 - 2) Pressure Limits: At least 5 times full-scale range, but not less than system design pressure rating.
 - 3) Temperature Limits: Minus 10 to 180 deg F.
 - 4) Operating Range: Approximately 2 times set point.
 - 5) Deadband: Fixed.

2.6 LIQUID-PRESSURE TRANSMITTERS

A. Liquid-Pressure Differential Transmitter:

- 1. Performance:
 - a. Range: Approximately 2 times the set point.
 - b. Span: Adjustable plus or minus one milliamp, noninteractive.
 - c. Accuracy: Within 0.25 percent of full scale.
 - d. Hysteresis: Within 0.1 percent of full scale.
 - e. Repeatability: Within 0.05 percent of full scale.
 - f. Maximum Working Pressure: 250 psig.
 - g. Temperature Limits: Zero to 175 deg F.
 - h. Compensate Temperature Limits: 30 to 150 deg F.
 - i. Thermal Effects: 0.02 percent of full scale per degree F.
 - j. Response Time: 30 to 50 ms.
 - k. Shock and vibration shall not harm the transmitter.
- 2. Analog Output Current Signal:
 - a. Two-wire, 4- to 20-mA dc current source.
 - b. Signal capable of operating into 1000-ohm load.
- 3. Analog Output Voltage Signal:
 - a. Three wire, zero to 5 or 10 V or 2 to 10 V.
 - b. Minimum Load Resistance: 1000 ohms.

4. Operator Interface:
 - a. Zero and span adjustments located behind cover.
 - b. Bleed screws on side of body, two screws on low-pressure side, and one screw on high-pressure side, for air in line and pressure cavity.
5. Construction:
 - a. Aluminum and stainless-steel enclosure with removable cover.
 - b. Wetted parts of transmitter constructed of 17-4 PH or 300 Series stainless steel.
 - c. Threaded, NPS 1/4 process connections on side of instrument enclosure.
 - d. Knock out for 1/2-inch nominal conduit connection on side of instrument enclosure.
 - e. Screw terminal block for wire connections.
 - f. NEMA 250, Type 4.
 - g. Mounting Bracket: Appropriate for installation.
6. Provide transmitter with three-valve manifold. Construct manifold of brass, bronze, or stainless steel. Provide manifold with NPS 1/4 NPT process connections.

2.7 SOURCE QUALITY CONTROL

- A. Factory Tests: Test and inspect assembled pressure instruments, as indicated by instrument requirements. Affix standards organization's certification and label.
- B. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for instruments installed in piping to verify actual locations of connections before installation.
- C. Examine roughing-in for instruments installed in duct systems to verify actual locations of connections before installation.
- D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Install products level, plumb, parallel, and perpendicular with building construction.

- B. Properly support instruments, tubing, piping wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement, sway, or a break in attachment when subjected to a force.
- C. Provide ceiling, floor, roof, wall openings, and sleeves required by installation. Before proceeding with drilling, punching, or cutting, check location first for concealed products that could potentially be damaged. Patch, flash, grout, seal, and refinish openings to match adjacent condition.
- D. Fastening Hardware:
 - 1. Stillson wrenches, pliers, and other tools that cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening nuts.
 - 2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by using excessive force or oversized wrenches.
- E. Install products in locations that are accessible and that permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

3.3 ELECTRICAL POWER

- A. Furnish and install electrical power to products requiring electrical connections.
- B. Furnish and install circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."
- C. Furnish and install power wiring. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- D. Furnish and install raceways. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems."

3.4 PRESSURE INSTRUMENT INSTALLATION

- A. Mounting Location:
 - 1. Rough-in: Outline instrument-mounting locations before setting instruments and routing, cable, wiring, tubing, and conduit to final location.
 - 2. Install switches and transmitters for air and liquid pressure associated with individual air-handling units and associated connected ductwork and piping near air-handlings units co-located in air-handling unit system control panel, to provide service personnel a single and convenient location for inspection and service.
 - 3. Install liquid pressure switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.

4. Install air-pressure switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.
 5. Mount switches and transmitters not required to be mounted within system control panels on walls, floor-supported freestanding pipe stands, or floor-supported structural support frames. Use manufacturer mounting brackets to accommodate field mounting. Securely support and brace products to prevent vibration and movement.
 6. Install instruments (except pressure gages) in liquid and liquid-sealed piped services below their process connection point. Slope tubing down to instrument with a slope of 2 percent.
 7. Install instruments in dry gas and noncondensable vapor piped services above their process connection point. Slope process connection lines up to instrument with a minimum slope of 2 percent.
- B. Seal penetrations to ductwork, plenums, and air-moving equipment to comply with duct static pressure class and leakage and seal classes indicated using neoprene gaskets or grommets.
- C. Duct Pressure Sensors:
1. Install sensors using manufacturer's recommended upstream and downstream distances.
 2. Unless indicated on Drawings, locate sensors approximately 67 percent of distance of longest duct pressure drop run. Location of sensors shall be submitted and approved before installation.
 3. Install mounting hardware and gaskets to make sensor installation airtight.
 4. Route tubing from the sensor to transmitter.
 5. Use compression fittings at terminations.
 6. Install sensor in accordance with manufacturer's instructions.
 7. Support sensor to withstand maximum air velocity, turbulence, and vibration encountered to prevent instrument failure.
- D. Outdoor Pressure Sensors:
1. Install roof-mounted sensor in least-noticeable location and as far away from exterior walls as possible.
 2. Locate wall-mounted sensor in an inconspicuous location.
 3. Submit sensor location for approval before installation.
 4. Verify signal from sensor is stable and consistent to all connected transmitters. Modify installation to achieve proper signal.
 5. Route outdoor signal pipe full size of sensor connection to transmitters. Install branch connection of size required to match to transmitter.
 6. Install sensor signal pipe with dirt leg and drain valve below roof penetration.
 7. Insulate signal pipe with flexible elastomeric insulation as required to prevent condensation.
 8. Connect roof-mounted signal pipe exposed to outdoors to building grounding system.
- E. Air-Pressure Differential Switches:
1. Install air-pressure sensor in system for each switch connection. Install sensor in an accessible location for inspection and replacement.
 2. A single sensor may be used to share a common signal to multiple pressure instruments.

3. Install access door in duct and equipment to access sensors that cannot be inspected and replaced from outside.
4. Route NPS 3/8 tubing from sensor to switch connection.
5. Do not mount switches on rotating equipment.
6. Install switches in a location free from vibration, heat, moisture, or adverse effects, which could damage the switch and hinder accurate operation.
7. Install switches in an easily accessible location serviceable from floor.
8. Install switches adjacent to system control panel if within 50 feet; otherwise, locate switch in vicinity of system connection.

F. Liquid-Pressure Differential Switches:

1. Where process connections are located in mechanical equipment room, install switch in convenient and accessible location near system control panel.
2. Where process connections are installed outside mechanical rooms, route processing tubing to mechanical room housing system control panel and locate switch near system control panel.
3. Where multiple switches serving same system are installed in same room, install switches by system to provide service personnel a single and convenient location for inspection and service.
4. System process tubing connection shall be full size of switch connection, but not less than NPS 1/2. Install bushing if required to mate switch to system connection.
5. Connect process tubing from point of system connection and extend to switch.
6. Install isolation valves in process tubing as close to system connection as practical.
7. Install dirt leg and drain valve at each switch connection.
8. Do not mount switches on rotating equipment.
9. Install switches in a location free from vibration, heat, moisture, or adverse effects, which could damage the switch and hinder accurate operation.
10. Install switches in an easily accessible location serviceable from floor.

G. Liquid-Pressure Transmitters:

1. Where process connections are installed in mechanical equipment room, install transmitter in convenient and accessible location near system control panel.
2. Where process connections are installed outside mechanical rooms, route processing tubing to mechanical room housing system control panel and locate transmitter near system control panel.
3. Where multiple transmitters serving same system are installed in same room, install transmitters by system to provide service personnel a single and convenient location for inspection and service.
4. System process tubing connection shall be full size of switch connection, but not less than NPS 1/2. Install bushing if required to mate switch to system connection.
5. Connect process tubing from point of system connection and extend to transmitter.
6. Install isolation valves in process tubing as close to system connection as practical.
7. Install dirt leg and drain valve at each transmitter connection.
8. Do not mount transmitters on equipment.
9. Install in a location free from vibration, heat, moisture, or adverse effects, which could damage and hinder accurate operation.

3.5 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing shall have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Install engraved nameplate with instrument identification and on face of ceiling directly below instruments concealed above ceilings.

3.6 CHECKOUT PROCEDURES

- A. Check out installed products before continuity tests, leak tests, and calibration.
- B. Check instruments for proper location and accessibility.
- C. Check instruments for proper installation with respect to direction of flow, elevation, orientation, insertion depth, or other applicable considerations that impact performance.

3.7 ADJUSTMENT, CALIBRATION, AND TESTING

- A. Description:
 - 1. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.
 - 2. Provide a written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.
 - 3. For each analog instrument, perform a three-point calibration test for both linearity and accuracy.
 - 4. Equipment and procedures used for calibration shall comply with instrument manufacturer's recommendations.
 - 5. Provide diagnostic and test equipment for calibration and adjustment.
 - 6. Field instruments and equipment used to test and calibrate installed instruments shall have accuracy at least twice the instrument accuracy being calibrated. For example, an installed instrument with an accuracy of 1 percent shall be checked by an instrument with an accuracy of 0.5 percent.
 - 7. Calibrate each instrument according to instrument instruction manual supplied by manufacturer.
 - 8. If, after calibration, indicated performance cannot be achieved, replace out-of-tolerance instruments.
 - 9. Comply with field-testing requirements and procedures indicated by ASHRAE Guideline 11, "Field Testing of HVAC Control Components," in the absence of specific requirements, and to supplement requirements indicated.
- B. Analog Signals:
 - 1. Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.

2. Check analog current signals using a precision current meter at zero, 50, and 100 percent.

C. Digital Signals:

1. Check digital signals using a jumper wire.
2. Check digital signals using an ohmmeter to test for contact.

D. Sensors: Check sensors at zero, 50, and 100 percent of project design values.

E. Switches: Calibrate switches to make or break contact at set points indicated.

F. Transmitters:

1. Check and calibrate transmitters at zero, 50, and 100 percent of project design values.

3.8 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months from 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.

3.9 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain instrumentation and control devices.
- B. Coordinate pressure instrument demonstration video with operation and maintenance manuals and classroom instruction for use by Owner in operating, maintaining, and troubleshooting.
- C. Record videos on DVD disks.
- D. Owner shall have right to make additional copies of video for internal use without paying royalties.

END OF SECTION

SECTION 230923.27 - TEMPERATURE INSTRUMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Air temperature sensors.
2. Air temperature switches.
3. Air temperature RTD transmitters.
4. Liquid temperature sensors.
5. Liquid temperature switches.

B. Related Requirements:

1. Section 230923 "Direct-Digital Control System for HVAC" for control equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, and cable.

1.3 DEFINITIONS

- A. HART (Highway Addressable Remote Transducer) Protocol: The global standard for sending and receiving digital information across analog wires between smart devices and control or monitoring systems through bidirectional communication that provides data access between intelligent field instruments and host systems. A host can be any software application from a technician's hand-held device or laptop to a plant's process control, asset management, safety, or other system using any control platform.

- B. RTD: Resistance temperature detector.

1.4 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of the Section 013300 "Submittal Procedures" and the individual sections specifying the work.

- B. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.

- C. Product Data: For each type of product, including the following:

1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
3. Product description with complete technical data, performance curves, and product specification sheets.
4. Installation operation and maintenance instructions, including factors affecting performance.

D. Shop Drawings:

1. Include plans, elevations, sections, and mounting details.
2. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.
4. Include number-coded identification system for unique identification of wiring, cable, and tubing ends.

1.5 INFORMATIONAL SUBMITTALS

- A. Submittals shall comply with the requirements of the Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Coordination Drawings: Plan drawings and corresponding product installation details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 1. Product installation location shown in relationship to room, duct, pipe, and equipment.
 2. Wall-mounted instruments located in finished space showing relationship to light switches, fire-alarm devices, and other installed devices.
 3. Sizes and locations of wall access panels for instruments installed behind walls.
 4. Sizes and locations of ceiling access panels for instruments installed in inaccessible ceilings.
- C. Product Certificates: For each product requiring a certificate.
- D. Product Test Reports: For each product, for tests performed by manufacturer and witnessed by a qualified testing agency or a qualified testing agency.
- E. Field quality-control reports.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Submittals shall comply with the requirements of the Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Furnish extra materials and parts that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
- C. Provide two matching product(s) in Project inventory for each unique size and type of temperature instrument provided.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Environmental Conditions:
 - 1. Instruments shall operate without performance degradation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified and encountered for installed location.
 - a. If instrument alone cannot meet requirement, install instrument in a protective enclosure that is isolated and protected from conditions impacting performance. Enclosure shall be internally insulated, electrically heated, filtered, and ventilated as required by instrument and application.

2.2 AIR TEMPERATURE SENSORS

- A. Platinum RTDs: Common Requirements:
 - 1. 100 or 1000 ohms at zero deg C and a temperature coefficient of 0.00385 ohm/ohm/deg C.
 - 2. Two-wire, PTFE-insulated, 22-gage stranded copper leads.
 - 3. Performance Characteristics:
 - a. Range: Minus 50 to 275 deg F.
 - b. Interchangeable Accuracy: At 32 deg F within 0.5 deg F.
 - c. Repeatability: Within 0.5 deg F.
 - d. Self-Heating: Negligible.
 - 4. Transmitter Requirements:
 - a. Transmitter required for each 100-ohm RTD.
 - b. Transmitter optional for 1000-ohm RTD, contingent on compliance with end-to-end control accuracy.
- B. Platinum RTD, Single-Point Air Temperature Duct Sensors:

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1. 100 or 1000 ohms.
2. Temperature Range: Minus 50 to 275 deg F
3. Probe: Single-point sensor with a stainless-steel sheath.
4. Length: As required by application to achieve tip at midpoint of air tunnel, up to 18 inches.
5. Enclosure: Junction box with removable cover; NEMA 250, Type 1 for indoor applications and Type 4 for outdoor applications.
6. Gasket for attachment to duct or equipment to seal penetration airtight.
7. Conduit Connection: 1/2-inch

C. Platinum RTD, Air Temperature Averaging Sensors:

1. 100 or 1000 ohms.
2. Temperature Range: Minus 50 to 275 deg F
3. Multiple sensors to provide average temperature across entire length of sensor.
4. Rigid probe of aluminum, brass, copper, or stainless-steel sheath.
5. Flexible probe of aluminum, brass, copper, or stainless-steel sheath and formable to a 4-inch radius.
6. Length: As required by application to cover entire cross section of air tunnel.
7. Enclosure: Junction box with removable cover; NEMA 250, Type 1 for indoor applications and Type 4 for outdoor applications.
8. Gasket for attachment to duct or equipment to seal penetration airtight.
9. Conduit Connection: 1/2-inch

D. Platinum RTD Outdoor Air Temperature Sensors:

1. 100 or 1000 ohms.
2. Temperature Range: Minus 50 to 275 deg F
3. Probe: Single-point sensor with a stainless-steel sheath.
4. Solar Shield: Stainless steel.
5. Enclosure: NEMA 250, Type 4 or 4X junction box or combination conduit and outlet box with removable cover and gasket.
6. Conduit Connection: 1/2-inch trade size.

E. Platinum RTD Space Air Temperature Sensors:

1. 100 or 1000 ohms.
2. Temperature Range: Minus 50 to 212 deg F
3. Sensor assembly shall include a temperature sensing element mounted under a bright white, non-yellowing, plastic or flush, brushed-aluminum cover.
4. Provide a mounting plate that is compatible with the surface shape that it is mounted to and electrical box used.
5. Concealed wiring connection.

F. Thermal Resistors (Thermistors): Common Requirements:

1. 10,000 ohms at 25 deg C and a temperature coefficient of 23.5 ohms/ohm/deg C.
2. Two-wire, PTFE-insulated, 22-gage stranded copper leads.
3. Performance Characteristics:

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- a. Range: Minus 50 to 275 deg F.
 - b. Interchangeable Accuracy: At 77 deg F within 0.5 deg F.
 - c. Repeatability: Within 0.5 deg F.
 - d. Drift: Within 0.5 deg F over 10 years.
 - e. Self-Heating: Negligible.
4. Transmitter optional, contingent on compliance with end-to-end control accuracy.
- G. Thermistor, Single-Point Duct Air Temperature Sensors:
1. Temperature Range: Minus 50 to 275 deg F
 2. Probe: Single-point sensor with a stainless-steel sheath.
 3. Length: As required by application to achieve tip at midpoint of air tunnel, up to 18 inches.
 4. Enclosure: Junction box with removable cover; NEMA 250, Type 1 for indoor applications and Type 4 for outdoor applications.
 5. Gasket for attachment to duct or equipment to seal penetration airtight.
 6. Conduit Connection: 1/2- inch trade size
- H. Thermistor Averaging Air Temperature Sensors:
1. Temperature Range: Minus 50 to 275 deg F
 2. Multiple sensors to provide average temperature across entire length of sensor.
 3. Rigid probe of aluminum, brass, copper, or stainless-steel sheath.
 4. Flexible probe of aluminum, brass, copper, or stainless-steel sheath and formable to a 4-inch radius.
 5. Length: As required by application to cover entire cross section of air tunnel.
 6. Enclosure: Junction box with removable cover; NEMA 250, Type 1 for indoor applications and Type 4 for outdoor applications.
 7. Gasket for attachment to duct or equipment to seal penetration airtight.
 8. Conduit Connection: 1/2-inch trade size.
- I. Thermistor Outdoor Air Temperature Sensors:
1. Temperature Range: Minus 50 to 275 deg F
 2. Probe: Single-point sensor with a stainless-steel sheath.
 3. Solar Shield: Stainless steel.
 4. Enclosure: NEMA 250, Type 4 or 4X junction box or combination conduit and outlet box with removable cover and gasket.
 5. Conduit Connection: 1/2-inch trade size.
- J. Thermistor Space Air Temperature Sensors:
1. Temperature Range: Minus 50 to 212 deg F
 2. Sensor assembly shall include a temperature sensing element mounted under a bright white, non-yellowing, plastic or flush, brushed-aluminum cover.
 3. Provide a mounting plate that is compatible with the surface shape that it is mounted to and electrical box used.
 4. Concealed wiring connection.

K. Space Air Temperature Sensors for Use with DDC Controllers Controlling Terminal Units:

1. 100- or 1000-ohm platinum RTD or thermistor.
2. Thermistor:
 - a. Pre-aged, burned in, and coated with glass; inserted in a metal sleeve; and entire unit encased in epoxy.
 - b. Thermistor drift shall be less than plus or minus 0.5 deg F over 10 years.
3. Temperature Transmitter Requirements:
 - a. Mating transmitter required with each 100-ohm RTD.
 - b. Mating transmitters optional for 1000-ohm RTD and thermistor, contingent on compliance with end-to-end control accuracy.
4. Provide digital display of sensed temperature.
5. Provide sensor with local control.
 - a. Local override to turn HVAC on.
 - b. Local adjustment of temperature set point.
 - c. Both features shall be capable of manual override through control system operator.

2.3 AIR TEMPERATURE SWITCHES

A. Thermostat and Switch for Low Temperature Control in Duct Applications:

1. Description:
 - a. Two-position control.
 - b. Field-adjustable set point.
 - c. Manual or automatic reset as indicated on Drawings.
 - d. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Performance:
 - a. Operating Temperature Range: 15 to 55 deg F.
 - b. Temperature Differential: 5 deg F, non-adjustable and additive.
 - c. Enclosure Ambient Temperature: Minus 20 to 140 deg F.
 - d. Sensing Element Maximum Temperature: 250 deg F.
 - e. Voltage: 120-V ac.
 - f. Current: 16 FLA.
 - g. Switch Type: Two SPDT snap switches operate on coldest 12-inch section along element length.
3. Construction:
 - a. Vapor-Filled Sensing Element: Nominal 20 feet long.
 - b. Dual Temperature Scale: Fahrenheit and Celsius visible on face.

- c. Set-Point Adjustment: Screw.
- d. Enclosure: Painted metal, NEMA 250, Type 1.
- e. Electrical Connections: Screw terminals.
- f. Conduit Connection: 1/2-inch trade size.

2.4 AIR TEMPERATURE RTD TRANSMITTERS

- A. Source Limitations: Obtain temperature-measuring sensors and transmitters and airflow from single manufacturer.
- B. House electronics in NEMA 250 enclosure.
 - 1. Duct: Type 1.
 - 2. Outdoor: Type 4 or Type 4X.
 - 3. Space: Type 1.
- C. Conduit Connection: 1/2-inch
- D. Functional Characteristics:
 - 1. Input:
 - a. 100-ohm platinum RTD temperature coefficient of 0.00385 ohm/ohm/deg C, two-wire sensors.
 - b. 1000-ohm platinum RTD temperature coefficient of 0.00385 ohm/ohm/deg C, two-wire sensors.
 - 2. Span (Adjustable):
 - a. Space: 40 to 90 deg F.
 - b. Supply Air Cooling and Heating: 40 to 120 deg F.
 - c. Supply Air Cooling Only: 40 to 90 deg F.
 - d. Supply Air Heating Only: 40 to 120 deg F.
 - e. Exhaust Air: 50 to 100 deg F.
 - f. Return Air: 50 to 100 deg F.
 - g. Mixed Air: Minus 40 to 140 deg F.
 - h. Outdoor: Minus 40 to 140 deg F.
 - 3. Output: 4- to 20-mA dc, linear with temperature; RFI insensitive; minimum drive load of 600 ohms at 24-V dc .
 - 4. Zero and span field adjustments, plus or minus 5 percent of span. Minimum span of 50 deg F.
 - 5. Match sensor with temperature transmitter and factory calibrate together.
- E. Performance Characteristics:
 - 1. Calibration Accuracy: Within 0.1 percent of the span.
 - 2. Stability: Within 0.2 percent of the span for at least 6 months.
 - 3. Combined Accuracy: Within 0.5 percent.

2.5 LIQUID TEMPERATURE SENSORS, COMMERCIAL GRADE

A. RTD:

1. Description:

- a. Platinum with a value of 100 or 1000 ohms at zero deg C and a temperature coefficient of 0.00385 ohm/ohm/deg C.
- b. Encase RTD in a stainless-steel sheath with a 0.25-inch OD.
- c. Sensor Length: 4, 6, or 8 inches as required by application.
- d. Process Connection: Threaded, NPS 1/2
- e. Two-stranded copper lead wires.
- f. Powder-coated steel enclosure, NEMA 250, Type 4.
- g. Conduit Connection: 1/2-inch
- h. Performance Characteristics:
 - 1) Range: Minus 40 to 210 deg F.
 - 2) Interchangeable Accuracy: Within 0.54 deg F at 32 deg F.

B. Thermowells:

1. Stem: Straight or stepped shank formed from solid bar stock.
2. Material: Brass.
3. Process Connection: Threaded, NPS 3/4.
4. Sensor Connection: Threaded, NPS 1/2.
5. Bore: Sized to accommodate sensor with tight tolerance between sensor and well.
6. Furnish thermowells installed in insulated pipes and equipment with an extended neck.
7. Length: 4, 6, or 8 inches as required by application.
8. Thermowells furnished with heat-transfer compound to eliminate air gap between wall of sensor and thermowell and to reduce time constant.

2.6 LIQUID TEMPERATURE SWITCHES

A. Thermostat and Switch for Temperature Control in Pipe Applications:

1. Description:

- a. Two-position control.
- b. Field-adjustable set point.
- c. Manual reset.
- d. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Performance:

- a. Operating Temperature Range: 65 to 200 deg F.
- b. Temperature Differential Deadband: 5 to 30 deg F, adjustable.
- c. Enclosure Ambient Temperature: 150 deg F.
- d. Sensing Element Pressure Rating: 200 psig.

- e. Voltage: 120-V ac.
 - f. Current: 8 FLA.
 - g. Switch Type: SPDT snap switch.
3. Construction:
- a. Vapor-Filled Immersion Element: Copper, nominal 3 inches long.
 - b. Temperature Scale: Fahrenheit, visible on face.
 - c. Set-Point Adjustment: Screw.
 - d. Enclosure: Painted metal, NEMA 250, Type 1.
 - e. Electrical Connections: Screw terminals.
 - f. Conduit Connection: 3/4-inch.

2.7 LIQUID AND STEAM TEMPERATURE TRANSMITTERS, COMMERCIAL GRADE

- A. House electronics in NEMA 250, Type 4 enclosure.
- B. Enclosure Connection: 1/2-inch trade size.
- C. Functional Characteristics:
 - 1. Input: 100-ohm platinum RTD temperature coefficient of 0.00385 ohm/ohm/deg C, two- or three-wire sensors.
 - 2. Default Span (Adjustable):
 - a. Chilled Water: Zero to 100 deg F.
 - b. Condenser Water: Zero to 120 deg F.
 - c. Heating Hot Water: 32 to 212 deg F.
 - d. Heat Recovery: Zero to 120 deg F.
 - 3. Output: 4- to 20-mA dc, linear with temperature; RFI insensitive; minimum drive load of 600 ohms at 24-V dc.
 - 4. Zero and span field adjustments, plus or minus 5 percent of span. Minimum span of 50 deg F.
 - 5. Match sensor with temperature transmitter and factory calibrate together. Each matched sensor and transmitter set shall include factory calibration data traceable to NIST.
- D. Performance Characteristics:
 - 1. Calibration Accuracy: Within 0.1 percent of the span.
 - 2. Stability: Within 0.2 percent of the span for at least 6 months.
 - 3. Combined Accuracy: Within 0.5 percent.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for instruments installed in piping to verify actual locations of connections before installation.
- C. Examine roughing-in for instruments installed in duct systems to verify actual locations of connections before installation.
- D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Install products level, plumb, parallel, and perpendicular with building construction.
- B. Properly support instruments, tubing, piping, wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment when subjected to a force.
- C. Fastening Hardware:
 - 1. Stillson wrenches, pliers, and other tools that cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening nuts.
 - 2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
- D. Install products in locations that are accessible and that permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

3.3 ELECTRIC POWER

- A. Furnish and install electrical power to products requiring electrical connections.
- B. Furnish and install circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."
- C. Furnish and install power wiring. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- D. Furnish and install raceways. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems."

3.4 TEMPERATURE INSTRUMENT INSTALLATIONS

A. Mounting Location:

1. Roughing In:

- a. Outline instrument mounting locations before setting instruments and routing cable, wiring, tubing, and conduit to final location.
- b. Provide independent inspection to confirm that proposed mounting locations comply with requirements indicated and approved submittals.
 - 1) Indicate dimensioned locations with mounting height for all surface-mounted products on Shop Drawings.
 - 2) Do not begin installation without submittal approval of mounting location.
- c. Complete installation rough-in only after confirmation by independent inspection is complete and approval of location is documented for review by Owner and Architect on request.

2. Install switches and transmitters for air and liquid temperature associated with individual air-handling units and associated connected ductwork and piping near air-handling units co-located in air-handling unit system control panel to provide service personnel a single and convenient location for inspection and service.
3. Install liquid temperature switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.
4. Install air temperature switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.
5. Mount switches and transmitters on walls, floor-supported freestanding pipe stands, or floor-supported structural support frames. Use manufacturer's mounting brackets to accommodate field mounting. Securely support and brace products to prevent vibration and movement.

B. Special Mounting Requirements:

1. Temperature instruments having performance impacted by temperature of mounting substrate shall be isolated with an insulating barrier located between instrument and substrate to eliminate effect. Where instruments requiring insulation are located in finished space, conceal insulating barrier in a cover matching the instrument cover.

C. Mounting Height:

1. Mount temperature instruments in user-occupied space to match mounting height of light switches unless otherwise indicated on Drawings. Mounting height shall comply with codes and accessibility requirements.
2. Mount switches and transmitters located in mechanical equipment rooms and other similar space not subject to code or state and Federal accessibility requirements within a range of 42 to 54 inches above the adjacent floor, grade, or service catwalk or platform.

- D. Seal penetrations to ductwork, plenums, and air-moving equipment to comply with duct static-pressure class and leakage and seal classes indicated using neoprene gaskets or grommets.
- E. Space Temperature Sensor Installation:
 - 1. Conceal assembly in an electrical box of sufficient size to house sensor and transmitter, if provided.
 - 2. Install electrical box with a faceplate to match sensor cover if sensor cover does not completely cover electrical box.
 - 3. In finished areas, recess electrical box within wall.
 - 4. In unfinished areas, electrical box may be surface mounted if electrical light switches are surface mounted. Use a cast-aluminum electric box for surface-mounted installations.
 - 5. Align electrical box with other electrical devices such as visual alarms and light switches located in the vicinity to provide a neat and well-thought-out arrangement. Where possible, align in both horizontal and vertical axis.
- F. Outdoor Air Temperature Sensor Installation:
 - 1. Mount sensor in a discrete location facing north.
 - 2. Protect installed sensor from solar radiation and other influences that could impact performance.
 - 3. If required to have a transmitter, mount transmitter remote from sensor in an accessible and serviceable location indoors.
- G. Single-Point Duct Temperature Sensor Installation:
 - 1. Install single-point-type, duct-mounted, supply- and return-air temperature sensors. Install sensors in ducts with sensitive portion of the element installed in center of duct cross section and located to sense near average temperature. Do not exceed 24 inches in sensor length.
 - 2. Install return-air sensor in location that senses return-air temperature without influence from outdoor or mixed air.
 - 3. Rigidly support sensor to duct and seal penetration airtight.
 - 4. If required to have transmitter, mount transmitter remote from sensor at accessible and serviceable location.
- H. Averaging Duct Temperature Sensor Installation:
 - 1. Install averaging-type air temperature sensor for temperature sensors located within air-handling units, similar equipment, and large ducts with air tunnel cross-sectional area of 20 sq. ft. and larger.
 - 2. Install sensor length to maintain coverage over entire cross-sectional area. Install multiple sensors where required to maintain the minimum coverage.
 - 3. Fasten and support sensor with manufacturer-furnished clips to keep sensor taut throughout entire length.
 - 4. If required to have transmitter, mount transmitter in an accessible and serviceable location.
- I. Low-Limit Air Temperature Switch Installation:

1. Install multiple low-limit switches to maintain coverage over entire cross-sectional area of air tunnel.
2. Fasten and support sensing element with manufacturer-furnished clips to keep element taut throughout entire length.
3. Mount switches outside of airstream at a location and mounting height to provide easy access for switch set-point adjustment and manual reset.
4. Install on entering side of cooling coil unless otherwise indicated on Drawings.

J. Liquid Temperature Sensor Installation:

1. Assembly shall include sensor, thermowell.
2. For pipe NPS 4 and larger, install sensor and thermowell length to extend into pipe between 50 to 75 percent of pipe cross section.
3. For pipe smaller than NPS 4:
 - a. Install reducers to increase pipe size to NPS 4 at point of thermowell installation.
 - b. For pipe sizes NPS 2-1/2 and NPS 3, thermowell and sensor may be installed at pipe elbow or tee to achieve manufacturer-recommended immersion depth in lieu of increasing pipe size.
 - c. Minimum insertion depth shall be 2-1/2 inches.
4. Install matching thermowell.
5. Fill thermowell with heat-transfer fluid before inserting sensor.
6. Tip of spring-loaded sensors shall contact inside of thermowell.
7. For insulated piping, install thermowells with extension neck to extend beyond face of insulation.
8. Install thermowell in top dead center of horizontal pipe positioned in an accessible location to allow for inspection and replacement. If top dead center location is not possible due to field constraints, install thermowell at location along top half of pipe.
9. For applications with transmitters, mount transmitter remote from sensor in an accessible and serviceable location from floor.

3.5 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing shall have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Install engraved nameplate with instrument identification.

3.6 CLEANING

- A. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from exposed interior and exterior surfaces.
- B. Wash and shine glazing.

- C. Polish glossy surfaces to a clean shine.

3.7 CHECK-OUT PROCEDURES

- A. Check installed products before continuity tests, leak tests, and calibration.
- B. Check temperature instruments for proper location and accessibility.
- C. Verify sensing element type and proper material.
- D. Verify location and length.
- E. Verify that wiring is correct and secure.

3.8 ADJUSTMENT, CALIBRATION, AND TESTING

A. Description:

1. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.
2. Provide a written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.
3. For each analog instrument, make a three-point test of calibration for both linearity and accuracy.
4. Equipment and procedures used for calibration shall meet instrument manufacturer's written instructions.
5. Provide diagnostic and test equipment for calibration and adjustment.
6. Field instruments and equipment used to test and calibrate installed instruments shall have accuracy at least twice the instrument accuracy being calibrated. For example, an installed instrument with an accuracy of 1 percent shall be checked by an instrument with an accuracy of 0.5 percent.
7. Calibrate each instrument according to instrument instruction manual supplied by manufacturer.
8. If after calibration indicated performance cannot be achieved, replace out-of-tolerance instruments.
9. Comply with field-testing requirements and procedures indicated by ASHRAE Guideline 11, "Field Testing of HVAC Control Components," in the absence of specific requirements and to supplement requirements indicated.

B. Analog Signals:

1. Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.
2. Check analog current signals using a precision current meter at zero, 50, and 100 percent.
3. Check resistance signals for temperature sensors at zero, 50, and 100 percent of operating span using a precision-resistance source.

C. Digital Signals:

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1. Check digital signals using a jumper wire.
 2. Check digital signals using an ohmmeter to test for contact.
- D. Sensors: Check sensors at zero, 50, and 100 percent of Project design values.
- E. Switches: Calibrate switches to make or break contact at set points indicated.
- F. Transmitters:
1. Check and calibrate transmitters at zero, 50, and 100 percent of Project design values.
 2. Calibrate resistance temperature transmitters at zero, 50, and 100 percent of span using a precision-resistance source.

3.9 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
1. Perform according to manufacturer's written instruction.
 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Prepare test and inspection reports.

3.10 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months from 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.

3.11 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain temperature instruments.
- B. Provide a complete set of instructional videos covering each product specified and installed and showing the following:
1. Software programming.
 2. Calibration and test procedures.
 3. Operation and maintenance requirements and procedures.
 4. Troubleshooting procedures.
- C. Coordinate video with operation and maintenance manuals and classroom instruction for use by Owner in operating, maintaining, and troubleshooting.
- D. Record videos on DVD disks.
- E. Owner shall have right to make additional copies of video for internal use without paying royalties.

END OF SECTION

SECTION 231123 - FACILITY NATURAL-GAS PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Pipes, tubes, and fittings.
 - 2. Piping specialties.
 - 3. Piping and tubing joining materials.
 - 4. Manual gas shutoff valves.
 - 5. Pressure regulators.
 - 6. Service meters.
 - 7. Dielectric fittings.

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspace, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

1.4 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Product Data: On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied. For each type of the following:
 - 1. Piping specialties.
 - 2. Corrugated, stainless-steel tubing with associated components.
 - 3. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.

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4. Pressure regulators. Indicate pressure ratings and capacities.
 5. Service meters. Indicate pressure ratings and capacities. Include bypass fittings and meter bars.
 6. Dielectric fittings.
- C. Shop Drawings: For facility natural-gas piping layout. Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.
1. Detail mounting, supports, and valve arrangements for service meter assembly and pressure regulator assembly.

1.5 INFORMATIONAL SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Coordination Drawings: Plans and details, drawn to scale, on which natural-gas piping is shown and coordinated with other installations, using input from installers of the items involved.
- C. Site Survey: Plans, drawn to scale, on which natural-gas piping is shown and coordinated with other services and utilities.
- D. Welding certificates.
- E. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For pressure regulators and service meters to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Steel Support 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. 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.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping according to requirements of authorities having jurisdiction.
- B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.
- D. Protect stored PE pipes and valves from direct sunlight.

1.9 PROJECT CONDITIONS

- A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.
- B. Interruption of Existing Natural-Gas Service and Connections to Existing Gas Main: Do not interrupt natural-gas service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide purging and startup of natural-gas supply according to requirements indicated:
 - 1. Connections to gas main and laying of gas piping from main to building, including regulator on exterior of building by Unitil. Coordinate trenching with Unitil. Provide at least 15 business days of requiring gas main installation.
 - 2. Notify Owner no fewer than seven days in advance of proposed interruption of natural-gas service.
 - 3. Do not proceed with interruption of natural-gas service without Owner's written permission.

1.10 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.
- B. Coordinate requirements for access panels and doors for valves installed concealed behind finished surfaces. Comply with requirements in Section 083113 "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Minimum Operating-Pressure Ratings:
 - 1. Piping and Valves: 100 psig minimum unless otherwise indicated.
 - 2. Service Regulators: 100 psig minimum unless otherwise indicated.

3. Minimum Operating Pressure of Service Meter: 5 psig.

B. Natural-Gas System Pressure within Buildings: More than 0.5 psig but not more than 2 psig.

2.2 PIPES, TUBES, AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.

1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
 - a. Material Group: 1.1.
 - b. End Connections: Threaded or butt welding to match pipe.
 - c. Lapped Face: Not permitted underground.
 - d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
 - e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.

B. PE Pipe: ASTM D 2513, SDR 11.

1. PE Fittings: ASTM D 2683, socket-fusion type or ASTM D 3261, butt-fusion type with dimensions matching PE pipe.
2. PE Transition Fittings: Factory-fabricated fittings with PE pipe complying with ASTM D 2513, SDR 11; and steel pipe complying with ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
3. Anodeless Service-Line Risers: Factory fabricated and leak tested.
 - a. Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet.
 - b. Casing: Steel pipe complying with ASTM A 53/A 53M, Schedule 40, black steel, Type E or S, Grade B, with corrosion-protective coating covering. Vent casing aboveground.
 - c. Aboveground Portion: PE transition fitting.
 - d. Outlet shall be threaded or flanged or suitable for welded connection.
 - e. Tracer wire connection.
 - f. Ultraviolet shield.
 - g. Stake supports with factory finish to match steel pipe casing or carrier pipe.
4. Transition Service-Line Risers: Factory fabricated and leak tested.
 - a. Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet connected to steel pipe complying with ASTM A 53/A 53M, Schedule 40, Type E or S, Grade B, with corrosion-protective coating for aboveground outlet.
 - b. Outlet shall be threaded or flanged or suitable for welded connection.

- c. Bridging sleeve over mechanical coupling.
- d. Factory-connected anode.
- e. Tracer wire connection.
- f. Ultraviolet shield.
- g. Stake supports with factory finish to match steel pipe casing or carrier pipe.

2.3 PIPING SPECIALTIES

A. Appliance Flexible Connectors:

1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
2. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
3. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.
4. Corrugated stainless-steel tubing with polymer coating.
5. Operating-Pressure Rating: 0.5 psig.
6. End Fittings: Zinc-coated steel.
7. Threaded Ends: Comply with ASME B1.20.1.
8. Maximum Length: 72 inches

B. Quick-Disconnect Devices: Comply with ANSI Z21.41.

1. Copper-alloy convenience outlet and matching plug connector.
2. Nitrile seals.
3. Hand operated with automatic shutoff when disconnected.
4. For indoor or outdoor applications.
5. Adjustable, retractable restraining cable.

C. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

D. Basket Strainers:

1. Body: ASTM A 126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

E. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

2.4 JOINING MATERIALS

- A. Joint Compound and Tape: Suitable for natural gas.
- B. 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.

2.5 MANUAL GAS SHUTOFF VALVES

- A. See "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles for where each valve type is applied in various services.
- B. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.
 - 1. CWP Rating: 125 psig.
 - 2. Threaded Ends: Comply with ASME B1.20.1.
 - 3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
 - 4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 - 5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
 - 6. Service Mark: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.
- C. General Requirements for Metallic Valves, NPS 2-1/2 and Larger: Comply with ASME B16.38.
 - 1. CWP Rating: 125 psig.
 - 2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
 - 3. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 - 4. Service Mark: Initials "WOG" shall be permanently marked on valve body.
- D. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.
 - 1. Body: Bronze, complying with ASTM B 584.
 - 2. Ball: Chrome-plated bronze.
 - 3. Stem: Bronze; blowout proof.
 - 4. Seats: Reinforced TFE; blowout proof.
 - 5. Packing: Threaded-body packnut design with adjustable-stem packing.
 - 6. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 - 7. CWP Rating: 600 psig.
 - 8. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
 - 9. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- E. Bronze Plug Valves: MSS SP-78.

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1. Body: Bronze, complying with ASTM B 584.
2. Plug: Bronze.
3. Ends: Threaded, socket, or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
4. Operator: Square head or lug type with tamperproof feature where indicated.
5. Pressure Class: 125 psig.
6. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
7. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

F. Valve Boxes:

1. Cast-iron, two-section box.
2. Top section with cover with "GAS" lettering.
3. Bottom section with base to fit over valve and barrel a minimum of 5 inches in diameter.
4. Adjustable cast-iron extensions of length required for depth of bury.
5. Include tee-handle, steel operating wrench with socket end fitting valve nut or flat head, and with stem of length required to operate valve.

2.6 PRESSURE REGULATORS

A. General Requirements:

1. Single stage and suitable for natural gas.
2. Steel jacket and corrosion-resistant components.
3. Elevation compensator.
4. End Connections: Threaded for regulators NPS 2 and smaller; flanged for regulators NPS 2-1/2 and larger.

B. Service Pressure Regulators: Comply with ANSI Z21.80.

1. Body and Diaphragm Case: Cast iron or die-cast aluminum.
2. Springs: Zinc-plated steel; interchangeable.
3. Diaphragm Plate: Zinc-plated steel.
4. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
5. Orifice: Aluminum; interchangeable.
6. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
7. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
8. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
9. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
10. Maximum Inlet Pressure: 100 psig.

C. Line Pressure Regulators: Comply with ANSI Z21.80.

1. Body and Diaphragm Case: Cast iron or die-cast aluminum.

2. Springs: Zinc-plated steel; interchangeable.
3. Diaphragm Plate: Zinc-plated steel.
4. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
5. Orifice: Aluminum; interchangeable.
6. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
7. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
8. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
9. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
10. Maximum Inlet Pressure: 5 psig.

D. Appliance Pressure Regulators: Comply with ANSI Z21.18.

1. Body and Diaphragm Case: Die-cast aluminum.
2. Springs: Zinc-plated steel; interchangeable.
3. Diaphragm Plate: Zinc-plated steel.
4. Seat Disc: Nitrile rubber.
5. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
6. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.
7. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.
8. Maximum Inlet Pressure: 2 psig.

2.7 SERVICE METERS

A. Diaphragm-Type Service Meters:

1. Case: Die-cast aluminum.
2. Connections: Steel threads.
3. Diaphragm: Synthetic fabric.
4. Diaphragm Support Bearings: Self-lubricating.
5. Compensation: Continuous temperature.
6. Meter Index: Cubic feet.
7. Meter Case and Index: Tamper resistant.
8. Remote meter reader compatible.
9. Maximum Inlet Pressure: 100 psig.
10. Pressure Loss: Maximum 0.5-inch wg.
11. Accuracy: Maximum plus or minus 1.0 percent.

B. Service-Meter Bars:

1. Malleable- or cast-iron frame for supporting service meter.
2. Include offset swivel pipes, meter nuts with o-ring seal, and factory- or field-installed dielectric unions.
3. Omit meter offset swivel pipes if service-meter bar dimensions match service-meter connections.

C. Service-Meter Bypass Fittings:

1. Ferrous, tee, pipe fitting with capped side inlet for temporary natural-gas supply.
2. Integral ball-check bypass valve.

2.8 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:

1. Description:
 - a. Standard: ASSE 1079.
 - b. Pressure Rating: 125 psig minimum at 180 deg F.
 - c. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

1. Description:
 - a. Standard: ASSE 1079.
 - b. Factory-fabricated, bolted, companion-flange assembly.
 - c. Pressure Rating: 125 psig minimum at 180 deg F.
 - d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:

1. Description:
 - a. Nonconducting materials for field assembly of companion flanges.
 - b. Pressure Rating: 150 psig.
 - c. Gasket: Neoprene or phenolic.
 - d. Bolt Sleeves: Phenolic or polyethylene.
 - e. Washers: Phenolic with steel backing washers.

2.9 LABELING AND IDENTIFYING

A. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored yellow.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Close equipment shutoff valves before turning off natural gas to premises or piping section.
- B. Inspect natural-gas piping according to NFPA 54 and the International Fuel Gas Code to determine that natural-gas utilization devices are turned off in piping section affected.
- C. Comply with NFPA 54 and the International Fuel Gas Code requirements for prevention of accidental ignition.

3.3 OUTDOOR PIPING INSTALLATION

- A. Exterior piping from gas main up to (and including) meter shall be provided by Unitil. Provide trenching and backfill as necessary for gas line installation.
- B. Comply with NFPA 54 and the International Fuel Gas Code for installation and purging of natural-gas piping.
- C. Install underground, natural-gas piping buried at least 36 inches below finished grade unless indicated otherwise on drawings. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.
 - 1. If natural-gas piping is installed less than 36 inches below finished grade, install it in containment conduit.
- D. Install underground, PE, natural-gas piping according to ASTM D 2774.
- E. Install fittings for changes in direction and branch connections.
- F. Install pressure gage upstream and downstream from each service regulator. Pressure gages are specified in Section 230519 "Meters and Gages for HVAC Piping."

3.4 INDOOR PIPING INSTALLATION

- A. Comply with NFPA 54 and the International Fuel Gas Code for installation and purging of natural-gas piping.

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- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.
- D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- E. 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.
- F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- G. Locate valves for easy access.
- H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.
- I. Install piping free of sags and bends.
- J. Install fittings for changes in direction and branch connections.
- K. Verify final equipment locations for roughing-in.
- L. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.
- M. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.
 - 1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 6 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.
- N. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.
- O. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.
- P. Concealed Location Installations: Except as specified below, install concealed natural-gas piping and piping installed under the building in containment conduit constructed of steel pipe with welded joints as described in Part 2. Install a vent pipe from containment conduit to outdoors and terminate with weatherproof vent cap.

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1. Above Accessible Ceilings: Natural-gas piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.
 2. In Floor Channels: Install natural-gas piping in floor channels. Channels must have cover and be open to space above cover for ventilation.
 3. In Walls or Partitions: Protect tubing installed inside partitions or hollow walls from physical damage using steel striker barriers at rigid supports.
 - a. Exception: Tubing passing through partitions or walls does not require striker barriers.
 4. Prohibited Locations:
 - a. Do not install natural-gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
 - b. Do not install natural-gas piping in solid walls or partitions.
- Q. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
- R. Connect branch piping from top or side of horizontal piping.
- S. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.
- T. Do not use natural-gas piping as grounding electrode.
- U. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.
- V. Install pressure gage upstream and downstream from each line regulator. Pressure gages are specified in Section 230519 "Meters and Gages for HVAC Piping."
- W. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."
- X. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."
- Y. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."
- 3.5 SERVICE-METER ASSEMBLY INSTALLATION
- A. Install service-meter assemblies aboveground.
 - B. Install metal shutoff valves upstream from service regulators. Shutoff valves are not required at second regulators if two regulators are installed in series.

- C. Install strainer on inlet of service-pressure regulator and meter set.
- D. Install service regulators mounted outside with vent outlet horizontal or facing down. Install screen in vent outlet if not integral with service regulator.
- E. Install metal shutoff valves upstream from service meters. Install dielectric fittings downstream from service meters.
- F. Install service meters downstream from pressure regulators.
- G. Install metal bollards to protect meter assemblies. Comply with requirements in Section 055000 "Metal Fabrications" for pipe bollards.

3.6 VALVE INSTALLATION

- A. Install manual gas shutoff valve for each gas appliance ahead of appliance flexible connector.
- B. Install underground valves with valve boxes.
- C. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.
- D. Install anode for metallic valves in underground PE piping.

3.7 PIPING JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Threaded Joints:
 - 1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
 - 2. Cut threads full and clean using sharp dies.
 - 3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
 - 4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
 - 5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- D. Welded Joints:
 - 1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
 - 2. Bevel plain ends of steel pipe.
 - 3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

- E. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.
- F. Flared Joints: Cut tubing with roll cutting tool. Flare tube end with tool to result in flare dimensions complying with SAE J513. Tighten finger tight, then use wrench. Do not overtighten.
- G. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
 - 1. Plain-End Pipe and Fittings: Use butt fusion.
 - 2. Plain-End Pipe and Socket Fittings: Use socket fusion.

3.8 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for pipe hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- B. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:
 - 1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
 - 2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8 inch.
 - 3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
 - 4. NPS 2-1/2 to NPS 3-1/2: Maximum span, 10 feet; minimum rod size, 1/2 inch.
 - 5. NPS 4 and Larger: Maximum span, 10 feet; minimum rod size, 5/8 inch.

3.9 CONNECTIONS

- A. Connect to utility's gas main according to utility's procedures and requirements.
- B. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.
- C. Install piping adjacent to appliances to allow service and maintenance of appliances.
- D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.
- E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.10 LABELING AND IDENTIFYING

- A. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for piping and valve identification.

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- B. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.11 PAINTING

- A. Comply with requirements in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting" for painting interior and exterior natural-gas piping.
- B. Paint exposed, exterior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.
 - 1. Alkyd System: MPI EXT 5.1D.
 - a. Prime Coat: Alkyd anticorrosive metal primer.
 - b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
 - c. Topcoat: Exterior alkyd enamel (semigloss).
 - d. Color: Yellow.
- C. Paint exposed, interior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.
 - 1. Latex Over Alkyd Primer System: MPI INT 5.1Q.
 - a. Prime Coat: Quick-drying alkyd metal primer.
 - b. Topcoat: Interior latex (semigloss).
 - c. Color: Yellow.
- D. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.12 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Test, inspect, and purge natural gas according to NFPA 54 and the International Fuel Gas Code and authorities having jurisdiction.
- C. Natural-gas piping will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.13 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain earthquake valves.

3.14 OUTDOOR PIPING SCHEDULE

- A. Underground natural-gas piping from gas main to building to be provided by Unitil.
- B. Underground natural-gas piping shall be the following:
 - 1. PE pipe and fittings joined by heat fusion, or mechanical couplings; service-line risers with tracer wire terminated in an accessible location.
- C. Aboveground natural-gas piping shall be the following:
 - 1. Steel pipe with malleable-iron fittings and threaded joints.
- D. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

3.15 INDOOR PIPING SCHEDULE

- A. Aboveground, branch piping NPS 1 and smaller shall be the following:
 - 1. Steel pipe with malleable-iron fittings and threaded joints.
- B. Aboveground, distribution piping shall be one of the following:
 - 1. Steel pipe with malleable-iron fittings and threaded joints.
 - 2. Steel pipe with wrought-steel fittings and welded joints.
- C. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.
- D. Containment Conduit Vent Piping: Steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.

3.16 UNDERGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

- A. Connections to Existing Gas Piping: Use valve and fitting assemblies made for tapping utility's gas mains and listed by an NRTL.
- B. Underground:
 - 1. PE valves.
 - 2. NPS 2 and Smaller: Bronze plug valves.

3. NPS 2-1/2 and Larger: Cast-iron, plug valves.

3.17 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

- A. Valves for pipe at service meter shall be one of the following:
 1. Two-piece, full-port, bronze ball valves with bronze trim.
 2. Bronze plug valve.
- B. Distribution piping valves shall be one of the following:
 1. Two-piece, full-port, bronze ball valves with bronze trim.
 2. Bronze plug valve.
- C. Valves in branch piping for single appliance shall be one of the following:
 1. One-piece, bronze ball valve with bronze trim.
 2. Two-piece, full-port, bronze ball valves with bronze trim.
 3. Bronze plug valve.

END OF SECTION

SECTION 232113 - HYDRONIC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes pipe and fitting materials and joining methods for the following:
 - 1. Copper tube and fittings.
 - 2. Steel pipe and fittings.
 - 3. Joining materials.
 - 4. Transition fittings.
 - 5. Dielectric fittings.
 - 6. Bypass chemical feeder.
- B. Sustainable Design Requirements: Work included in this specification shall conform to the US Green Building Council LEED requirements listed in Section 018113.23 "Sustainable Design Requirements - LEED 2009 for Schools."

1.3 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.
- C. Product Data: For each type of the following:
 - 1. Pipe.
 - 2. Fittings.
 - 3. Joining materials.
 - 4. Bypass chemical feeder.
- D. Sustainable Design Submittals:
 - 1. Product Data: For adhesives, indicating VOC content.
 - 2. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
 - 3. Environmental Product Declaration: For each product.
 - 4. Health Product Declaration: For each product.

5. Sourcing of Raw Materials: Corporate sustainability report for each manufacturer.

1.4 INFORMATIONAL SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Coordination Drawings: Piping layout, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 1. Suspended ceiling components.
 2. Other building services.
 3. Structural members.
- C. Qualification Data: For Installer.
- D. Welding certificates.
- E. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications:
 1. Installers of Pressure-Sealed Joints: Installers shall be certified by pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.
- B. Steel Support Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- C. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
 1. Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.
 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature unless otherwise indicated:
 1. Hot-Water Heating Piping: 100 psig at 200 deg F.

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2. Makeup-Water Piping: 150 psig at 150 deg F.
3. Air-Vent Piping: 200 deg F.
4. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

2.2 COPPER TUBE AND FITTINGS

- A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.
- B. DWV Copper Tubing: ASTM B 306, Type DWV.
- C. Copper Pipe Nipples With Threaded End Connections: ASME B16.18
- D. Wrought-Copper, Solder Joint Pressure Fittings, Unions, and Flanges: ASME B16.22.

2.3 STEEL PIPE AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; welded and seamless, Grade B, and wall thickness as indicated in "Piping Applications" Article.
- B. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in "Piping Applications" Article.
- C. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in "Piping Applications" Article.
- D. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in "Piping Applications" Article.
- E. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.
- F. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
 1. Material Group: 1.1.
 2. End Connections: Butt welding.
 3. Facings: Raised face.
- G. Steel Pipe Nipples: ASTM A 733, made of same materials and wall thicknesses as pipe in which they are installed.

2.4 JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless otherwise indicated.

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- a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
- B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- D. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.
- E. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.5 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- B. Dielectric Unions:
- 1. Description:
 - a. Standard: ASSE 1079.
 - b. Pressure Rating: 125 psig minimum at 180 deg F.
 - c. End Connections: Solder-joint copper alloy and threaded ferrous.
- C. Dielectric-Flange Insulating Kits:
- 1. Description:
 - a. Nonconducting materials for field assembly of companion flanges.
 - b. Pressure Rating: 150 psig.
 - c. Gasket: Neoprene or phenolic.
 - d. Bolt Sleeves: Phenolic or polyethylene.
 - e. Washers: Phenolic with steel backing washers.
- D. Dielectric Nipples:
- 1. Description:
 - a. Standard: IAPMO PS 66.
 - b. Electroplated steel nipple, complying with ASTM F 1545.
 - c. Pressure Rating: 300 psig at 225 deg F.
 - d. End Connections: Male threaded or grooved.
 - e. Lining: Inert and noncorrosive, propylene.

2.6 BYPASS CHEMICAL FEEDER

- A. Description: Welded steel construction; 125-psig working pressure; 5-gal. capacity; with fill funnel and inlet, outlet, and drain valves.
 - 1. Chemicals: Specially formulated, based on analysis of makeup water, to prevent accumulation of scale and corrosion in piping and connected equipment.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

- A. Hot-water heating piping, aboveground, NPS 2 and smaller, shall be any of the following:
 - 1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
 - 2. Schedule 40, Grade B, Type 96 steel pipe; Class 150, malleable-iron fittings; cast-iron flanges and flange fittings; and threaded or welded joints.
- B. Hot-water heating piping, aboveground, NPS 2-1/2 and larger, shall be the following:
 - 1. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
- C. Makeup-water piping installed aboveground shall be the following:
 - 1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
- D. Condensate-Drain Piping: Type DWV, drawn-temper copper tubing, wrought-copper fittings, and soldered joints or Schedule 40 PVC plastic pipe and fittings and solvent-welded joints.
- E. Air-Vent Piping:
 - 1. Inlet: Same as service where installed.
 - 2. Outlet: Copper tubing with soldered joints.
- F. Safety-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed.

3.2 PIPING INSTALLATIONS

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems and are diagrammatic in nature. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

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- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.
- F. Install piping at indicated slopes.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Install piping to allow application of insulation.
- J. Select system components with pressure rating equal to or greater than system operating pressure.
- K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- L. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
- M. Install piping at a uniform grade of 0.2 percent upward in direction of flow.
- N. Reduce pipe sizes using eccentric reducer fitting installed with level side down.
- O. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.
- P. Install valves according to the following:
 - 1. Section 230523.11 "Globe Valves for HVAC Piping."
 - 2. Section 230523.12 "Ball Valves for HVAC Piping."
 - 3. Section 230523.14 "Check Valves for HVAC Piping."
 - 4. Section 230523.15 "Gate Valves for HVAC Piping."
- Q. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
- R. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.
- S. Install shutoff valve immediately upstream of each dielectric fitting.
- T. Comply with requirements in Section 230516 "Expansion Fittings and Loops for HVAC Piping" for installation of expansion loops, expansion joints, anchors, and pipe alignment guides.

- U. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for identifying piping.
- V. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."
- W. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."
- X. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

3.3 DIELECTRIC FITTING INSTALLATION

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric nipples or unions.
- C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flange kits or nipples.
- D. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.4 HANGERS AND SUPPORTS

- A. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hanger, support, and anchor devices. Comply with the following requirements for maximum spacing of supports.
- B. Comply with requirements in Section 230548.13 "Vibration Controls for HVAC" for vibration isolation requirements.
- C. Install the following pipe attachments:
 - 1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
 - 2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
 - 3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
 - 4. Spring hangers to support vertical runs.
 - 5. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
 - 6. On plastic pipe, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.
- D. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:
 - 1. NPS 3/4: Maximum span, 7 feet.

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2. NPS 1: Maximum span, 7 feet.
 3. NPS 1-1/2: Maximum span, 9 feet.
 4. NPS 2: Maximum span, 10 feet.
 5. NPS 2-1/2: Maximum span, 11 feet.
 6. NPS 3 and Larger: Maximum span, 12 feet.
- E. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:
1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
 2. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
 3. NPS 1-1/4: Maximum span, 7 feet; minimum rod size, 3/8 inch.
 4. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 5. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 6. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
 7. NPS 3 and Larger: Maximum span, 10 feet; minimum rod size, 3/8 inch.
- F. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

3.5 PIPE JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- D. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8/A5.8M.
- E. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- F. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
- G. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.6 TERMINAL EQUIPMENT CONNECTIONS

- A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.
- B. Install control valves in accessible locations close to connected equipment.
- C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.
- D. Install ports for pressure gages and thermometers at coil inlet and outlet connections. Comply with requirements in Section 230519 "Meters and Gages for HVAC Piping."

3.7 CHEMICAL TREATMENT

- A. Perform an analysis of makeup water to determine type and quantities of chemical treatment needed to keep system free of scale, corrosion, and fouling, and to sustain the following water characteristics:
 - 1. pH: 9.0 to 10.5.
 - 2. "P" Alkalinity: 100 to 500 ppm.
 - 3. Boron: 100 to 200 ppm.
 - 4. Soluble Copper: Maximum of 0.20 ppm.
 - 5. Total Suspended Solids: Maximum of 10 ppm.
 - 6. Ammonia: Maximum of 20 ppm.
- B. Install bypass chemical feeders in each hydronic system where indicated.
 - 1. Install in upright position with top of funnel not more than 48 inches above the floor.
 - 2. Install feeder in minimum NPS 3/4 bypass line, from main with full-size, full-port, ball valve in the main between bypass connections.
 - 3. Install NPS 3/4 pipe from chemical feeder drain to nearest equipment drain and include a full-size, full-port, ball valve.
- C. Fill system with fresh water and add liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products from piping. Circulate solution for a minimum of 24 hours, drain, clean strainer screens, and refill with fresh water.
- D. Add initial chemical treatment and maintain water quality in ranges noted above for the first year of operation.
- E. Fill systems that have antifreeze or glycol solutions with the following concentrations:
 - 1. Hot-Water Heating Piping: Minimum of 35 percent glycol, by volume.

3.8 FIELD QUALITY CONTROL

- A. Prepare hydronic piping according to ASME B31.9 and as follows:

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1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing.
2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
3. Isolate expansion tanks and determine that hydronic system is full of water.
4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times the "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

C. Perform the following before operating the system:

1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Set makeup pressure-reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.
6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
7. Verify lubrication of motors and bearings.

END OF SECTION

SECTION 232116 - HYDRONIC PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes the following:

1. Hydronic specialty valves.
2. Air-control devices.
3. Strainers.
4. Connectors.

- B. Related Requirements:

1. Section 230516 "Expansion Fittings and Loops for HVAC Piping" for expansion fittings and loops.
2. Section 230523.12 "Ball Valves for HVAC Piping" for specification and installation requirements for ball valves common to most piping systems.
3. Section 230523.14 "Check Valves for HVAC Piping" for specification and installation requirements for check valves common to most piping systems.
4. Section 230523.15 "Gate Valves for HVAC Piping" for specification and installation requirements for gate valves common to most piping systems.
5. Section 230923.11 "Control Valves" for automatic control valve and sensor specifications, installation requirements, and locations.

1.3 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.

- B. Product Data: For each type of the following. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.

1. Hydronic Specialty Valves: Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
2. Air-control devices.
3. Strainers.
4. Connectors.

1.4 CLOSEOUT SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Operation and Maintenance Data: For air-control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
 - 1. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 - PRODUCTS

2.1 HYDRONIC SPECIALTY VALVES

- A. Bronze, Calibrated-Orifice, Balancing Valves:
 - 1. Body: Bronze, ball or plug type with calibrated orifice or venturi.
 - 2. Ball: Brass or stainless steel.
 - 3. Plug: Resin.
 - 4. Seat: PTFE.
 - 5. End Connections: Threaded or socket.
 - 6. Pressure Gage Connections: Integral seals for portable differential pressure meter.
 - 7. Handle Style: Lever, with memory stop to retain set position.
 - 8. CWP Rating: Minimum 125 psig.
 - 9. Maximum Operating Temperature: 250 deg F.
- B. Cast-Iron or Steel, Calibrated-Orifice, Balancing Valves:
 - 1. Body: Cast-iron or steel body, ball, plug, or globe pattern with calibrated orifice or venturi.
 - 2. Ball: Brass or stainless steel.
 - 3. Stem Seals: EPDM O-rings.
 - 4. Disc: Glass and carbon-filled PTFE.
 - 5. Seat: PTFE.
 - 6. End Connections: Flanged or grooved.
 - 7. Pressure Gage Connections: Integral seals for portable differential pressure meter.
 - 8. Handle Style: Lever, with memory stop to retain set position.
 - 9. CWP Rating: Minimum 125 psig.
 - 10. Maximum Operating Temperature: 250 deg F.

C. Diaphragm-Operated, Pressure-Reducing Valves: ASME labeled.

1. Body: Bronze or brass.
2. Disc: Glass and carbon-filled PTFE.
3. Seat: Brass.
4. Stem Seals: EPDM O-rings.
5. Diaphragm: EPT.
6. Low inlet-pressure check valve.
7. Inlet Strainer: Removable without system shutdown.
8. Valve Seat and Stem: Noncorrosive.
9. Valve Size, Capacity, and Operating Pressure: Selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

D. Diaphragm-Operated Safety Valves: ASME labeled.

1. Body: Bronze or brass.
2. Disc: Glass and carbon-filled PTFE.
3. Seat: Brass.
4. Stem Seals: EPDM O-rings.
5. Diaphragm: EPT.
6. Wetted, Internal Work Parts: Brass and rubber.
7. Inlet Strainer: Removable without system shutdown.
8. Valve Seat and Stem: Noncorrosive.
9. Valve Size, Capacity, and Operating Pressure: Comply with ASME Boiler and Pressure Vessel Code: Section IV, and selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

E. Automatic Flow-Control Valves:

1. Body: Brass or ferrous metal.
2. Piston and Spring Assembly: Stainless steel, tamper proof, self-cleaning, and removable.
3. Combination Assemblies: Include bronze or brass-alloy ball valve.
4. Identification Tag: Marked with zone identification, valve number, and flow rate.
5. Size: Same as pipe in which installed.
6. Performance: Maintain constant flow, plus or minus 5 percent over system pressure fluctuations.
7. Minimum CWP Rating: 175 psig.
8. Maximum Operating Temperature: 250 deg F.

2.2 AIR-CONTROL DEVICES

A. Manual Air Vents:

1. Body: Bronze.
2. Internal Parts: Nonferrous.
3. Operator: Screwdriver or thumbscrew.
4. Inlet Connection: NPS 1/2.
5. Discharge Connection: NPS 1/8.
6. CWP Rating: 150 psig.

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7. Maximum Operating Temperature: 225 deg F.

B. Automatic Air Vents:

1. Body: Bronze or cast iron.
2. Internal Parts: Nonferrous.
3. Operator: Noncorrosive metal float.
4. Inlet Connection: NPS 1/2.
5. Discharge Connection: NPS 1/4.
6. CWP Rating: 150 psig.
7. Maximum Operating Temperature: 240 deg F.

C. Bladder-Type Expansion Tanks:

1. Tank: Welded steel, rated for 125-psig working pressure and 375 deg F maximum operating temperature. Factory test after tanks are fabricated and supports installed and are labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
2. Bladder: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.
3. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.

D. Tangential-Type Air Separators:

1. Tank: Welded steel; ASME constructed and labeled for 125-psig minimum working pressure and 375 deg F maximum operating temperature.
2. Air Collector Tube: Perforated stainless steel, constructed to direct released air into expansion tank.
3. Tangential Inlet and Outlet Connections: Threaded for NPS 2 and smaller; flanged connections for NPS 2-1/2 and larger.
4. Blowdown Connection: Threaded.
5. Size: Match system flow capacity.

E. In-Line Air Separators:

1. Tank: One-piece cast iron with an integral weir constructed to decelerate system flow to maximize air separation.
2. Maximum Working Pressure: Up to 175 psig.
3. Maximum Operating Temperature: Up to 300 deg F.

2.3 STRAINERS

A. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: Stainless-steel, mesh strainer, or perforated stainless-steel basket.
4. CWP Rating: 125 psig.

2.4 CONNECTORS

A. Stainless-Steel Bellow, Flexible Connectors:

1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
2. End Connections: Threaded or flanged to match equipment connected.
3. Performance: Capable of 3/4-inch misalignment.
4. CWP Rating: 150 psig.
5. Maximum Operating Temperature: 250 deg F.

PART 3 - EXECUTION

3.1 VALVE APPLICATIONS

- A. Install shutoff-duty valves at each branch connection to supply mains and at supply connection to each piece of equipment.
- B. Install calibrated-orifice, balancing valves at each branch connection to return main.
- C. Install calibrated-orifice, balancing valves in the return pipe of each heating or cooling terminal.
- D. Install check valves at each pump discharge and elsewhere as required to control flow direction.
- E. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.
- F. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

3.2 HYDRONIC SPECIALTIES INSTALLATION

- A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.
- B. Install automatic air vents at high points of system piping in mechanical equipment rooms only. Install manual vents at heat-transfer coils and elsewhere as required for air venting.
- C. Install piping from boiler air outlet, air separator, or air purger to expansion tank with a 2 percent upward slope toward tank.
- D. Install in-line air separators in pump suction. Install drain valve on air separators NPS 2 and larger.
- E. Install tangential air separator in pump suction. Install blowdown piping with gate or full-port ball valve; extend full size to nearest floor drain.

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- F. Install expansion tanks on the floor. Vent and purge air from hydronic system, and ensure that tank is properly charged with air to suit system Project requirements.

END OF SECTION

SECTION 232123 - HYDRONIC PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Close-coupled, in-line centrifugal pumps.
2. Separately coupled, base-mounted, end-suction centrifugal pumps.
3. Wet-rotor pumps.
4. Automatic condensate pump units.

- B. Sustainable Design Requirements: Work included in this specification shall conform to the US Green Building Council LEED requirements listed in Section 018113.23 "Sustainable Design Requirements - LEED 2009 for Schools."

1.3 DEFINITIONS

- A. Buna-N: Nitrile rubber.
- B. EPT: Ethylene propylene terpolymer.

1.4 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Product Data: For each type of pump. Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.
- C. Shop Drawings: For each pump.
 1. Show pump layout and connections.
 2. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.
 3. Include diagrams for power, signal, and control wiring.

1.5 CLOSEOUT SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 CLOSE-COUPLED, IN-LINE CENTRIFUGAL PUMPS

- A. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally or vertically.
- B. Capacities and Characteristics: As scheduled on Drawings.
- C. Pump Construction:
 - 1. Casing: Radially split, cast iron, with threaded gage tappings at inlet and outlet, replaceable bronze wear rings, and threaded companion-flange connections.
 - 2. Impeller: ASTM B 584, 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: Steel, with copper-alloy shaft sleeve.
 - 4. Pump Bearings: Permanently lubricated ball bearings.
- D. Motor: Single speed and rigidly mounted to pump casing.
 - 1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - a. Enclosure: Open, dripproof.
 - b. Motor Bearings: Permanently lubricated ball bearings.
 - c. Efficiency: Premium efficient.

2.2 SEPARATELY COUPLED, BASE-MOUNTED, END-SUCTION CENTRIFUGAL PUMPS

- A. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, end-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for base mounting, with pump and motor shafts horizontal.

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- B. Capacities and Characteristics: As scheduled on Drawings.
- C. Pump Construction:
 - 1. Casing: Radially split, cast iron, with replaceable bronze wear rings, threaded gage tappings at inlet and outlet, drain plug at bottom and air vent at top of volute, and flanged connections. Provide integral mount on volute to support the casing, and provide attached piping to allow removal and replacement of impeller without disconnecting piping or requiring the realignment of pump and motor shaft.
 - 2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For pumps not frequency-drive controlled, trim impeller to match specified performance.
 - 3. Pump Shaft: Steel, with copper-alloy shaft sleeve.
 - 4. Pump Bearings: Grease-lubricated ball bearings in cast-iron housing with grease fittings.
- D. Shaft Coupling: Molded-rubber insert and interlocking spider capable of absorbing vibration. Couplings shall be drop-out type to allow disassembly and removal without removing pump shaft or motor.
- E. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.
- F. Mounting Frame: Welded-steel frame and cross members, factory fabricated from ASTM A 36/A 36M channels and angles. Fabricate to mount pump casing, coupling guard, and motor.
- G. Motor: Single speed, secured to mounting frame, with adjustable alignment.
 - 1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - a. Enclosure: Open, dripproof.
 - b. Motor Bearings: Permanently lubricated ball bearings.
 - c. Efficiency: Premium efficient.

2.3 WET-ROTOR PUMPS

- A. Description: Factory-assembled and -tested, wet-rotor pump.
- B. Capacities and Characteristics: As scheduled on Drawings.
- C. Pump Construction:
 - 1. Body: Cast iron.
 - 2. Impeller: Polypropylene or noryl.

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3. Pump Shaft: Ceramic or stainless steel.
4. Bearings. Double-sintered carbon.

D. Motor: Single speed.

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - a. Efficiency: Premium efficient.

2.4 AUTOMATIC CONDENSATE PUMP UNITS

- A. Description: Packaged units with corrosion-resistant pump, plastic tank with cover, and automatic controls. Include factory- or field-installed check valve and a 72-inch- minimum, electrical power cord with plug.
- B. Capacities and Characteristics: As scheduled on Drawings.

2.5 PUMP SPECIALTY FITTINGS

- A. Suction Diffuser:
 1. Angle pattern.
 2. 175-psig pressure rating, cast or ductile-iron body and end cap, pump-inlet fitting.
 3. Bronze startup and bronze or stainless-steel permanent strainers.
 4. Bronze or stainless-steel straightening vanes.
 5. Drain plug.
 6. Factory-fabricated support.
- B. Triple-Duty Valve: Not allowed.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of the 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.

3.2 PUMP INSTALLATION

- A. Comply with HI 1.4 and HI 2.4.
- B. Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories.
- C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.
- D. Automatic Condensate Pump Units: Install units for collecting condensate and extend to open drain.
- E. Equipment Mounting:
 - 1. Install base-mounted pumps on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
 - 2. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."
- F. Equipment Mounting: Install in-line pumps with continuous-thread hanger rods and spring hangers with vertical-limit stop of size required to support weight of in-line pumps.
 - 1. Comply with requirements for hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

3.3 ALIGNMENT

- A. Perform alignment service.
- B. Comply with requirements in Hydronics Institute 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.
- C. Comply with pump and coupling manufacturers' written instructions.
- D. 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.

3.4 CONNECTIONS

- A. Where installing piping adjacent to pump, allow space for service and maintenance.
- B. Connect piping to pumps. Install valves that are same size as piping connected to pumps.

- C. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.
- D. Install check valve and throttling valve with memory stop on discharge side of pumps.
- E. Install suction diffuser and shutoff valve on suction side of pumps.
- F. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.
- G. Install pressure gages on pump suction and discharge or at integral pressure-gage tapping, or install single gage with multiple-input selector valves.
- H. Install check valve and gate or ball valve on each condensate pump unit discharge.
- I. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- J. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.5 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Check piping connections for tightness.
 - 3. Clean strainers on suction piping.
 - 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.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps.

END OF SECTION

SECTION 233113 - METAL DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Single-wall rectangular ducts and fittings.
2. Single-wall round ducts and fittings.
3. Sheet metal materials.
4. Sealants and gaskets.
5. Hangers and supports.

B. Related Sections:

1. Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Section 233300 "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

- C. Sustainable Design Requirements: Work included in this specification shall conform to the US Green Building Council LEED requirements listed in Section 018113.23 "Sustainable Design Requirements - LEED 2009 for Schools."

1.3 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Duct hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

- B. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.4 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.

- B. Product Data: On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied. For each type of the following products:
 - 1. Sealants and gaskets.
- C. Sustainable Design Submittals:
 - 1. **Product Data:** For ventilation equipment, indicating compliance with ASHRAE 62.1, Section 5 - "Systems and Equipment."
 - 2. **Product Data:** For adhesives, indicating VOC content.
 - 3. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
 - 4. **Product Data:** For sealants, indicating VOC content.
 - 5. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.

1.5 INFORMATIONAL SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
 - 2. Suspended ceiling components.
 - 3. Structural members to which duct will be attached.
 - 4. Size and location of initial access modules for acoustical tile.
 - 5. Penetrations of smoke barriers and fire-rated construction.
 - 6. Items penetrating finished ceiling including the following:
 - a. Luminaires.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Sprinklers.
 - e. Access panels.
 - f. Perimeter moldings.
- C. Welding certificates.
- D. Field quality-control reports.

1.6 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.

- B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."
- C. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 SINGLE-WALL ROUND DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.

- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 1. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
- D. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 SHEET METAL MATERIALS

- A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 - 1. Galvanized Coating Designation: G90.
 - 2. Finishes for Surfaces Exposed to View: Mill phosphatized.
- C. Carbon-Steel Sheets: Comply with ASTM A 1008/A 1008M, with oiled, matte finish for exposed ducts.
- D. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the "Duct Schedule" Article.
- E. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- F. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.4 SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
- B. Water-Based Joint and Seam Sealant:

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1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

C. Flanged Joint Sealant: Comply with ASTM C 920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.
6. Sealant shall have a VOC content of 420 g/L or less.
7. 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."

D. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

E. Round Duct Joint O-Ring Seals:

1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.5 HANGERS AND SUPPORTS

- A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
- B. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."
- C. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.
- D. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.
- E. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

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- F. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- G. Trapeze and Riser Supports:
 - 1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
 - 2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
 - 3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.
- B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- C. Install ducts in maximum practical lengths.
- D. Install ducts with fewest possible joints.
- E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
- I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
- J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.
- K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Section 233300 "Air Duct Accessories" for fire and smoke dampers.

- L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

3.2 INSTALLATION OF EXPOSED DUCTWORK

- A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
- B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
- C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.
- D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
- E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 ADDITIONAL INSTALLATION REQUIREMENTS FOR COMMERCIAL KITCHEN HOOD EXHAUST DUCT

- A. Install commercial kitchen hood exhaust ducts without dips and traps that may hold grease, and sloped a minimum of 2 percent to drain grease back to the hood.
- B. Install fire-rated access panel assemblies at each change in direction and at maximum intervals of 12 feet in horizontal ducts, and at every floor for vertical ducts, or as indicated on Drawings.
- C. Do not penetrate fire-rated assemblies except as allowed by applicable building codes and authorities having jurisdiction.

3.4 DUCT SEALING

- A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

3.5 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

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1. Where practical, install concrete inserts before placing concrete.
 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
 3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
 4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
- D. Hangers Exposed to View: Threaded rod and angle or channel supports.
- E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.
- F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.6 CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.7 PAINTING

- A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

3.8 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Duct System Cleanliness Tests:
1. Visually inspect duct system to ensure that no visible contaminants are present.
 2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."

- a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.

- C. Duct system will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.9 DUCT CLEANING

- A. Clean new duct system(s) before testing, adjusting, and balancing.
- B. Use service openings for entry and inspection.
 1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 233300 "Air Duct Accessories" for access panels and doors.
 2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
 3. Remove and reinstall ceiling to gain access during the cleaning process.
- C. Particulate Collection and Odor Control:
 1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
 2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.
- D. Clean the following components by removing surface contaminants and deposits:
 1. Air outlets and inlets (registers, grilles, and diffusers).
 2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
 3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
 4. Coils and related components.
 5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
 6. Supply-air ducts, dampers, actuators, and turning vanes.
 7. Dedicated exhaust and ventilation components and makeup air systems.
- E. Mechanical Cleaning Methodology:
 1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.

2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Provide drainage and cleanup for wash-down procedures.
7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

3.10 START UP

- A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.11 DUCT SCHEDULE

- A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:

- B. Supply Ducts:

1. Ducts Connected to Terminal Units:
 - a. Pressure Class: Positive 2-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 24.
 - d. SMACNA Leakage Class for Round: 12.
2. Ducts Connected to Constant-Volume Air-Handling Units:
 - a. Pressure Class: Positive 3-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 24.
 - d. SMACNA Leakage Class for Round and Flat Oval: 12.
3. Ducts Connected to Variable-Air-Volume Air-Handling Units:
 - a. Pressure Class: Positive 4-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 6.
 - d. SMACNA Leakage Class for Round and Flat Oval: 6.

C. Return Ducts:

1. Ducts Connected to Terminal Units:
 - a. Pressure Class: Positive or negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 24.
 - d. SMACNA Leakage Class for Round and Flat Oval: 12.
2. Ducts Connected to Air-Handling Units:
 - a. Pressure Class: Positive or negative 3-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 24.
 - d. SMACNA Leakage Class for Round and Flat Oval: 12.

D. Exhaust Ducts:

1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
 - a. Pressure Class: Negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: B if negative pressure, and A if positive pressure.
 - c. SMACNA Leakage Class for Rectangular: 12.
 - d. SMACNA Leakage Class for Round: 6.
2. Ducts Connected to Air-Handling Units:
 - a. Pressure Class: Positive or negative 3-inch wg.
 - b. Minimum SMACNA Seal Class: B if negative pressure, and A if positive pressure.
 - c. SMACNA Leakage Class for Rectangular: 12.
 - d. SMACNA Leakage Class for Round and Flat Oval: 6.
3. Ducts Connected to Commercial Kitchen Hoods: Comply with NFPA 96.
 - a. Exposed to View: Type 304, stainless-steel sheet, No. 3 finish.
 - b. Concealed: Type 304, stainless-steel sheet, No. 2D finish.
 - c. Welded seams and joints.
 - d. Pressure Class: Positive or negative 3-inch wg.
 - e. Airtight/Watertight.
4. Ducts Connected to Dishwasher Hoods:
 - a. Type 304, stainless-steel sheet.
 - b. Exposed to View: No. 3 finish.
 - c. Concealed: No. 2D finish.
 - d. Welded seams and flanged joints with watertight EPDM gaskets.
 - e. Pressure Class: Positive or negative 2-inch wg.
 - f. Airtight/Watertight.

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E. Intermediate Reinforcement:

1. Galvanized-Steel Ducts: Galvanized steel.
2. Stainless-Steel Ducts:
 - a. Exposed to Airstream: Match duct material.
 - b. Not Exposed to Airstream: Match duct material.

F. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
 - a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
 - b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
 - c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."
 - a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
 - 1) Radius-to Diameter Ratio: 1.5.
 - b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
 - c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam.

G. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."
 - a. Rectangular Main to Rectangular Branch: 45-degree entry.
 - b. Rectangular Main to Round Branch: Spin in.
2. Round: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.
 - a. Velocity 1000 to 1500 fpm or Lower: Conical tap.
 - b. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION

SECTION 233300 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Backdraft dampers.
2. Manual volume dampers.
3. Fire dampers.
4. Turning vanes.
5. Duct-mounted access doors.
6. Flexible connectors.
7. Duct accessory hardware.

B. Related Requirements:

1. Section 233346 "Flexible Ducts" for insulated and non-insulated flexible ducts.
2. Section 233723 "HVAC Gravity Ventilators" for roof-mounted ventilator caps.
3. Section 283111 "Digital, Addressable Fire-Alarm System" for duct-mounted fire and smoke detectors.

- C. Sustainable Design Requirements: Work included in this specification shall conform to the US Green Building Council LEED requirements listed in Section 018113.23 "Sustainable Design Requirements - LEED 2009 for Schools."

1.3 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Product Data: For each type of product. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.
- C. Sustainable Design Submittals:
1. Product data showing compliance with ASHRAE 62.1.

1.4 INFORMATIONAL SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from Installers of the items involved.
- C. Source quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.2 MATERIALS

- A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 - 1. Galvanized Coating Designation: G90.
 - 2. Exposed-Surface Finish: Mill phosphatized.
- B. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304, and having a No. 2 finish for concealed ducts and No. 4 finish for exposed ducts.
- C. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- D. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 BACKDRAFT DAMPERS

- A. Description: Gravity balanced.
- B. Maximum Air Velocity: 3000 fpm.
- C. Maximum System Pressure: 3-inch wg.
- D. Frame: Hat-shaped, 0.05-inch-thick, galvanized sheet steel, with welded corners or mechanically attached and mounting flange.
- E. Blades: Multiple single-piece blades, off-center pivoted or end pivoted, maximum 6-inch width, 0.025-inch-thick, roll-formed aluminum with sealed edges.
- F. Blade Action: Parallel.
- G. Blade Seals: Extruded vinyl, mechanically locked.
- H. Blade Axles:
 - 1. Material: Stainless steel.
 - 2. Diameter: 0.20 inch.
- I. Tie Bars and Brackets: Aluminum.
- J. Return Spring: Adjustable tension.
- K. Bearings: Synthetic pivot bushings.
- 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 minimum.
 - b. Sleeve Length: 6 inches minimum.
 - 6. Screen Mounting: Rear mounted.
 - 7. Screen Material: Galvanized steel.
 - 8. Screen Type: Bird.
 - 9. 90-degree stops.

2.4 MANUAL VOLUME DAMPERS

- A. Standard, Steel, Manual Volume Dampers:
 - 1. Standard leakage rating, with linkage outside airstream.

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2. Suitable for horizontal or vertical applications.
3. Frames:
 - a. Frame: Hat-shaped, 0.094-inch-thick, galvanized sheet steel.
 - b. Mitered and welded corners.
 - c. Flanges for attaching to walls and flangeless frames for installing in ducts.
4. Blades:
 - a. Multiple or single blade.
 - b. Parallel- or opposed-blade design.
 - c. Stiffen damper blades for stability.
 - d. Galvanized-steel, 0.064 inch thick.
5. Blade Axles: Galvanized steel.
6. Bearings:
 - a. Molded synthetic.
 - b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
7. Tie Bars and Brackets: Galvanized steel.

B. Jackshaft:

1. Size: 1-inch diameter.
2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

C. Damper Hardware:

1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch- thick zinc-plated steel, and a 3/4-inch hexagon locking nut.
2. Include center hole to suit damper operating-rod size.
3. Include elevated platform for insulated duct mounting.

2.5 FIRE DAMPERS

- A. Type: Dynamic; rated and labeled according to UL 555 by an NRTL.
- B. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000-fpm velocity.
- C. Fire Rating: 1-1/2 and 3 hours.
- D. Frame: Curtain type with blades outside airstream; fabricated with roll-formed, 0.034-inch-thick galvanized steel; with mitered and interlocking corners.

- E. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
 - 1. Minimum Thickness: 0.05 or 0.138 inch 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, 0.034-inch-thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch-thick, galvanized-steel blade connectors.
- H. Horizontal Dampers: Include blade lock and stainless-steel closure spring.
- I. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.

2.6 TURNING VANES

- A. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
 - 1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.
- B. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."
- C. Vane Construction: Single wall.

2.7 DUCT-MOUNTED ACCESS DOORS

- A. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2, "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-inchbutt 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 Square: No hinges and two sash locks.

- b. Access Doors up to 18 Inches Square: Two hinges and two sash locks.

2.8 FLEXIBLE CONNECTORS

- A. Materials: Flame-retardant or noncombustible fabrics.
- B. Coatings and Adhesives: Comply with UL 181, Class 1.
- C. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to two strips of 2-3/4-inch-wide, 0.028-inch-thick, galvanized sheet steel or 0.032-inch-thick aluminum sheets. Provide metal compatible with connected ducts.
- D. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
 - 1. Minimum Weight: 26 oz./sq. yd..
 - 2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
 - 3. Service Temperature: Minus 40 to plus 200 deg F.

2.9 DUCT ACCESSORY HARDWARE

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.
- B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts.
- B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and stainless-steel accessories in stainless-steel ducts.
- C. Compliance with ASHRAE/IESNA 90.1-2004 includes Section 6.4.3.3.3 - "Shutoff Damper Controls," restricts the use of backdraft dampers, and requires control dampers for certain applications. Install backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
- D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts.
 - 1. Install steel volume dampers in steel ducts.

- E. Set dampers to fully open position before testing, adjusting, and balancing.
- F. Install test holes at fan inlets and outlets and elsewhere as indicated.
- G. Install fire dampers according to UL listing.
- H. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
 - 1. At outdoor-air intakes and mixed-air plenums.
 - 2. Downstream from control dampers, backdraft dampers, and equipment.
 - 3. Adjacent to and close enough to fire dampers, to reset or reinstall fusible links. Access doors for access to fire 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.
 - 4. At each change in direction and at maximum 50-foot spacing.
 - 5. Upstream and downstream from turning vanes.
 - 6. Elsewhere as indicated.
- I. Install access doors with swing against duct static pressure.
- J. Access Door Sizes:
 - 1. One-Hand or Inspection Access: 8 by 5 inches.
 - 2. Two-Hand Access: 12 by 12 inches.
 - 3. Head and Hand Access: 18 by 10 inches.
 - 4. Head and Shoulders Access: 21 by 14 inches.
 - 5. Body Access: 25 by 14 inches.
 - 6. Body plus Ladder Access: 25 by 17 inches.
- K. Label access doors according to Section 230553 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.
- L. Install flexible connectors to connect ducts to equipment.
- M. Connect terminal units to supply ducts with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.
- N. Connect diffusers to ducts with maximum 60-inch lengths of flexible duct clamped or strapped in place.
- O. Connect flexible ducts to metal ducts with draw bands and adhesive plus sheet metal screws.
- P. Install duct test holes where required for testing and balancing purposes.

3.2 FIELD QUALITY CONTROL

- A. Tests and Inspections:

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1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Operate fire dampers to verify full range of movement and verify that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation.
5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION

SECTION 233346 - FLEXIBLE DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Non-insulated flexible ducts.
 - 2. Insulated flexible ducts.
- B. Sustainable Design Requirements: Work included in this specification shall conform to the US Green Building Council LEED requirements listed in Section 018113.23 "Sustainable Design Requirements - LEED 2009 for Schools."

1.3 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Product Data: For each type of product. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.
- C. Sustainable Design Submittals:
 - 1. Product data showing compliance with ASHRAE 62.1.
 - 2. Product Data: For adhesives and sealants, indicating VOC content.
 - 3. Laboratory Test Reports: For adhesives and sealants, indicating compliance with requirements for low-emitting materials.
 - 4. Laboratory Test Reports: For Insulation, indicating compliance with requirements for low-emitting materials.
 - 5. Product Data: For insulation, indicating that R-values comply with tables in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air Conditioning."

1.4 INFORMATIONAL SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.

- B. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from installers of the items involved.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- B. 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.
- C. Comply with the Air Diffusion Council's "ADC Flexible Air Duct Test Code FD 72-R1."
- D. Comply with ASTM E 96/E 96M, "Test Methods for Water Vapor Transmission of Materials."

2.2 NON-INSULATED FLEXIBLE DUCTS

- A. Non-Insulated, Flexible Duct: UL 181, Class 1, two-ply vinyl film supported by helically wound, spring-steel wire.
 - 1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
 - 2. Maximum Air Velocity: 4000 fpm.
 - 3. Temperature Range: Minus 10 to plus 160 deg F.

2.3 INSULATED FLEXIBLE DUCTS

- A. Insulated, Flexible Duct: UL 181, Class 1, two-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene vapor-barrier film.
 - 1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
 - 2. Maximum Air Velocity: 4000 fpm.
 - 3. Temperature Range: Minus 10 to plus 160 deg F.
 - 4. Insulation R-Value: Comply with ASHRAE/IES 90.1, R4.2.

2.4 FLEXIBLE DUCT CONNECTORS

- A. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action or nylon strap in sizes 3 through 18 inches, to suit duct size.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install flexible ducts 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.
- B. Install in indoor applications only. Flexible ductwork should not be exposed to UV lighting.
- C. Connect terminal units to supply ducts directly or with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.
- D. Connect diffusers or light troffer boots to ducts directly or with maximum lengths of flexible duct clamped or strapped in place.
- E. Connect flexible ducts to metal ducts with draw bands and adhesive plus sheet metal screws.
- F. Install duct test holes where required for testing and balancing purposes.
- G. Installation:
 - 1. Install ducts fully extended.
 - 2. Do not bend ducts across sharp corners.
 - 3. Bends of flexible ducting shall not exceed a minimum of one duct diameter.
 - 4. Avoid contact with metal fixtures, water lines, pipes, or conduits.
 - 5. Install flexible ducts in a direct line, without sags, twists, or turns.
- H. Supporting Flexible Ducts:
 - 1. Suspend flexible ducts with bands 1-1/2 inches wide or wider and spaced a maximum of 48 inches apart. Maximum centerline sag between supports shall not exceed 1/2 inch per 12 inches.
 - 2. Install extra supports at bends placed approximately one duct diameter from center line of the bend.
 - 3. Ducts may rest on ceiling joists or truss supports. Spacing between supports shall not exceed the maximum spacing per manufacturer's written installation instructions.
 - 4. Vertically installed ducts shall be stabilized by support straps at a maximum of 72 inches o.c.

END OF SECTION

SECTION 233423 - HVAC POWER VENTILATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Centrifugal roof ventilators.
 - 2. Upblast propeller roof exhaust fans.
 - 3. Ceiling-mounted ventilators.
 - 4. In-line centrifugal fans.

1.3 PERFORMANCE REQUIREMENTS

- A. Project Altitude: Base fan-performance ratings on actual Project site elevations.
- B. Operating Limits: Classify according to AMCA 99.

1.4 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied. Also include the following:
 - 1. Certified fan performance curves with system operating conditions indicated.
 - 2. Certified fan sound-power ratings.
 - 3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
 - 4. Material thickness and finishes, including color charts.
 - 5. Dampers, including housings, linkages, and operators.
 - 6. Roof curbs.
 - 7. Fan speed controllers.

- C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Wiring Diagrams: For power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 “Submittal Procedures” and the individual sections specifying the work.
- B. Coordination Drawings: Reflected ceiling plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
 - 1. Roof framing and support members relative to duct penetrations.
 - 2. Ceiling suspension assembly members.
 - 3. Size and location of initial access modules for acoustical tile.
 - 4. Ceiling-mounted items including light fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
- C. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 “Submittal Procedures” and the individual sections specifying the work.
- B. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 “Submittal Procedures” and the individual sections specifying the work.
- B. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Belts: One set for each belt-driven unit.

1.8 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.

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- B. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.
- C. UL Standards: Power ventilators shall comply with UL 705. Power ventilators for use for restaurant kitchen exhaust shall also comply with UL 762.

1.9 COORDINATION

- A. Coordinate size and location of structural-steel support members.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided.
- C. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

PART 2 - PRODUCTS

2.1 CENTRIFUGAL ROOF VENTILATORS

- A. Housing: Removable, spun-aluminum, dome top and outlet baffle; square, one-piece, aluminum base with venturi inlet cone.
 - 1. Upblast Units: Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains and grease collector.
 - 2. Hinged Subbase: Galvanized-steel hinged arrangement permitting service and maintenance.
- B. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.
- C. Belt Drives:
 - 1. Resiliently mounted to housing.
 - 2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
 - 3. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
 - 4. Pulleys: Cast-iron, adjustable-pitch motor pulley.
 - 5. Fan and motor isolated from exhaust airstream.
- D. Accessories:
 - 1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
 - 2. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted outside fan housing, factory wired through an internal aluminum conduit.
 - 3. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.

- E. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch- thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.
 - 1. Configuration: Built-in raised cant and mounting flange.
 - 2. Overall Height: 16 inches.
 - 3. Sound Curb: Curb with sound-absorbing insulation.
 - 4. Pitch Mounting: Manufacture curb for roof slope.
 - 5. Metal Liner: Galvanized steel.
 - 6. Mounting Pedestal: Galvanized steel with removable access panel.
 - 7. Vented Curb: Unlined with louvered vents in vertical sides.

2.2 CEILING-MOUNTED VENTILATORS

- A. Housing: Steel, lined with acoustical insulation.
- B. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel shall be removable for service.
- C. Grille: Metal, louvered grille with flange on intake and thumbscrew attachment to fan housing.
- D. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.
- E. Accessories:
 - 1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
 - 2. Time-Delay Switch: Assembly with single-pole rocker switch, timer, and cover plate.
 - 3. Motion Sensor: Motion detector with adjustable shutoff timer.
 - 4. Isolation: Rubber-in-shear vibration isolators.
 - 5. Manufacturer's standard roof jack or wall cap, and transition fittings.

2.3 IN-LINE CENTRIFUGAL FANS

- A. Housing: Split, spun aluminum with aluminum straightening vanes, inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.
- B. Direct-Drive Units: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing.
- C. Belt-Driven Units: Motor mounted on adjustable base, with adjustable sheaves, enclosure around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing.
- D. Fan Wheels: Aluminum, airfoil blades welded to aluminum hub.
- E. Accessories:

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1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
2. Companion Flanges: For inlet and outlet duct connections.
3. Fan Guards: 1/2- by 1-inch mesh of galvanized steel in removable frame. Provide guard for inlet or outlet for units not connected to ductwork.
4. Motor and Drive Cover (Belt Guard): Epoxy-coated steel.

2.4 MOTORS

- A. 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. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
- B. Enclosure Type: Totally enclosed, fan cooled.

2.5 SOURCE QUALITY CONTROL

- A. Certify sound-power level ratings according to AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.
- B. Certify fan performance ratings, including flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating." Label fans with the AMCA-Certified Ratings Seal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install power ventilators level and plumb.
- B. Equipment Mounting:
 1. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."
- C. Secure roof-mounted fans to roof curbs with cadmium-plated hardware. See Section 077200 "Roof Accessories" for installation of roof curbs.
- D. Ceiling Units: Suspend units from structure; use steel wire or metal straps.

- E. Support suspended units from structure using threaded steel rods and elastomeric hangers or spring hangers with vertical-limit stops having a static deflection of 1 inch. Vibration-control devices are specified in Section 230548.13 "Vibration Controls for HVAC."
- F. Install units with clearances for service and maintenance.
- G. Label units according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

3.2 CONNECTIONS

- A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 233300 "Air Duct Accessories."
- B. Install ducts adjacent to power ventilators to allow service and maintenance.
- C. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
 - 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. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.

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10. Shut unit down and reconnect automatic temperature-control operators.
11. Remove and replace malfunctioning units and retest as specified above.

- C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Prepare test and inspection reports.

3.4 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Adjust belt tension.
- C. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.
- D. Replace fan and motor pulleys as required to achieve design airflow.
- E. Lubricate bearings.

3.5 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain exhaust fans.

END OF SECTION

SECTION 233600 - AIR TERMINAL UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Shutoff, single-duct air terminal units.
 - 2. Casing liner.
- B. Sustainable Design Requirements: Work included in this specification shall conform to the US Green Building Council LEED requirements listed in Section 018113.23 "Sustainable Design Requirements - LEED 2009 for Schools."

1.3 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Product Data: For each type of air terminal unit. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for air terminal units.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- C. Sustainable Design Submittals:
 - 1. Product Data: For ventilation equipment, indicating compliance with ASHRAE 62.1, Section 5 - "Systems and Equipment."
 - 2. Product Data: For adhesives, indicating VOC content.
 - 3. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
- D. Shop Drawings: For air terminal units.
 - 1. Include plans, elevations, sections, and mounting details.

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2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.
4. Hangers and supports, including methods for duct and building attachment and vibration isolation.

1.4 INFORMATIONAL SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 1. Ceiling suspension assembly members.
 2. Size and location of initial access modules for acoustic tile.
 3. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
- C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Operation and Maintenance Data: For air terminal units to include in emergency, operation, and maintenance manuals.
 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - a. Instructions for resetting minimum and maximum air volumes.
 - b. Instructions for adjusting software set points.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."

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- C. ASHRAE Compliance: Applicable requirements in ASHRAE/IES 90.1, "Section 6 - Heating, Ventilating, and Air Conditioning."

2.2 SHUTOFF, SINGLE-DUCT AIR TERMINAL UNITS

- A. Configuration: Volume-damper assembly inside unit casing with control components inside a protective metal shroud.
- B. Casing: 0.040-inch-thick galvanized steel, single wall.
 - 1. Casing Liner: Comply with requirements in "Casing Liner" Article for duct liner.
 - 2. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
 - 3. Air Outlet: S-slip and drive connections.
 - 4. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket.
 - 5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- C. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.
 - 1. Maximum Damper Leakage: AHRI 880 rated, 2 percent of nominal airflow at 3-inch wg inlet static pressure.
- D. Hydronic Heating Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain valve.
- E. Control devices shall be compatible with temperature controls system specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."
 - 1. Terminal Unit Controller: Pressure-independent, variable-air-volume (VAV) controller with electronic airflow transducer with multipoint velocity sensor at air inlet, factory calibrated to minimum and maximum air volumes, and having the following features:
 - a. Communication with temperature-control system specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."
- F. Controls:
 - 1. Suitable for operation with duct pressures between 0.25- and 3.0-inch wg inlet static pressure.

2.3 CASING LINER

- A. Casing Liner: Fibrous-glass duct liner, complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
 - 1. Minimum Thickness: 1/2 inch.

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- a. Maximum Thermal Conductivity: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
2. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
3. Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
 - a. Adhesive shall have a VOC content of 80 g/L or less.
 - b. Adhesive 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."

2.4 SOURCE QUALITY CONTROL

- A. Factory Tests: Test assembled air terminal units according to AHRI 880.
 1. Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, and AHRI certification seal.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 5, "Hangers and Supports" and with Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
 1. Coordinate locations of concrete inserts with locations of radiant tubing in second floor slab prior to installation.
 2. Where practical, install concrete inserts before placing concrete.
 3. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
 4. Use powder-actuated concrete fasteners for standard-weight aggregate concretes and for slabs more than 4 inches thick.
 5. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes and for slabs less than 4 inches thick.
 6. Do not use powder-actuated concrete fasteners for seismic restraints.
- C. Hangers Exposed to View: Threaded rod and angle or channel supports.
- D. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.2 TERMINAL UNIT INSTALLATION

- A. Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."
- B. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.
- C. Install wall-mounted thermostats.

3.3 CONNECTIONS

- A. Where installing piping adjacent to air terminal unit, allow space for service and maintenance.
- B. Hot-Water Piping: Comply with requirements in Section 232113 "Hydronic Piping" and Section 232116 Hydronic Piping Specialties," and connect heating coils to supply with shutoff valve, strainer, control valve, and union or flange; and to return with balancing valve and union or flange.
- C. Comply with requirements in Section 233113 "Metal Ducts" for connecting ducts to air terminal units.
- D. Make connections to air terminal units with flexible connectors complying with requirements in Section 233300 "Air Duct Accessories."

3.4 IDENTIFICATION

- A. Label each air terminal unit with plan number, nominal airflow, and maximum and minimum factory-set airflows. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for equipment labels and warning signs and labels.

3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Perform the following tests and inspections:
 - 1. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.
 - 2. Leak Test: After installation, fill water coils 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 motor rotation and unit operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Air terminal unit will be considered defective if it does not pass tests and inspections.

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- D. Prepare test and inspection reports.

3.6 STARTUP SERVICE

- A. Perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
 - 3. Verify that controls and control enclosure are accessible.
 - 4. Verify that control connections are complete.
 - 5. Verify that nameplate and identification tag are visible.
 - 6. Verify that controls respond to inputs as specified.

3.7 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain air terminal units.

END OF SECTION

SECTION 233713.13 - AIR DIFFUSERS AND GRILLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes: Supply-, return-, transfer- and exhaust-air diffusers and grilles.
- B. Related Requirements:
 - 1. Section 233300 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers.

1.3 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Product Data: For each type of product. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.
 - 1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
 - 2. Diffuser Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.
- C. Samples for Verification: For diffusers, in manufacturer's standard sizes to verify color selected. Actual size of smallest diffuser indicated.

1.4 INFORMATIONAL SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Ceiling suspension assembly members.
 - 2. Method of attaching hangers to building structure.
 - 3. Size and location of initial access modules for acoustical tile.

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4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
 5. Duct access panels.
- C. Source quality-control reports.

PART 2 - PRODUCTS

2.1 ROUND CEILING DIFFUSERS

- A. As scheduled on Drawings.

2.2 RECTANGULAR AND SQUARE CEILING DIFFUSERS AND GRILLES

- A. As scheduled on Drawings.

2.3 PERFORATED DIFFUSERS AND GRILLES

- A. As scheduled on Drawings.

2.4 LOUVER FACE DIFFUSERS AND GRILLES

- A. As scheduled on Drawings.

2.5 LINEAR BAR DIFFUSERS

- A. As scheduled on Drawings.

2.6 LINEAR SLOT DIFFUSERS

- A. As scheduled on Drawings.

2.7 CEILING-INTEGRAL CONTINUOUS DIFFUSERS

- A. As scheduled on Drawings.

2.8 HIGH-CAPACITY DRUM LOUVER DIFFUSERS

- A. As scheduled on Drawings.

2.9 SOURCE QUALITY CONTROL

- A. Verification of Performance: Rate diffusers according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas where diffusers and grilles are installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install diffusers and grilles aligned with ceilings, walls, and floors.
- B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
- C. Install diffusers and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

- A. After installation, adjust diffusers to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION

SECTION 233723 - HVAC GRAVITY VENTILATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Roof hoods.
 - 2. Goosenecks.
- B. Sustainable Design Requirements: Work included in this specification shall conform to the US Green Building Council LEED requirements listed in Section 018113.23 "Sustainable Design Requirements - LEED 2009 for Schools."

1.3 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Ventilators shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of ventilator components, noise or metal fatigue caused by ventilator blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures shall be considered to act normal to the face of the building.
 - 1. Wind Loads: Determine loads based on a uniform pressure of 20 lbf/sq. ft., acting inward or outward.
- B. Water Entrainment: Limit water penetration through unit to comply with ASHRAE 62.1.

1.4 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Product Data: For each type of product indicated. For louvered-penthouse ventilators specified to bear AMCA seal, include printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.
- C. Sustainable Design Submittals:

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1. **Product Data:** For ventilation equipment, indicating compliance with ASHRAE 62.1, Section 5 - "Systems and Equipment."
- D. **Shop Drawings:** For gravity ventilators. Include plans, elevations, sections, details, ventilator attachments to curbs, and curb attachments to roof structure.
 1. Show weep paths, gaskets, flashing, sealant, and other means of preventing water intrusion.

1.5 INFORMATIONAL SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. **Coordination Drawings:** Roof framing plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 1. Structural members to which roof curbs and ventilators will be attached.
 2. Sizes and locations of roof openings.
- C. **Seismic Qualification Certificates:** For ventilators, accessories, and components, from manufacturer.
 1. **Basis for Certification:** Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 2. **Dimensioned Outline Drawings of Equipment Unit:** Identify center of gravity and locate and describe mounting and anchorage provisions.
 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- D. Welding certificates.

1.6 QUALITY ASSURANCE

- A. **Welding Qualifications:** Qualify procedures and personnel according to the following:
 1. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
 2. AWS D1.3, "Structural Welding Code - Sheet Steel."

1.7 COORDINATION

- A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Aluminum Extrusions: ASTM B 221, Alloy 6063-T5 or T-52.
- B. Aluminum Sheet: ASTM B 209, Alloy 3003 or 5005 with temper as required for forming or as otherwise recommended by metal producer for required finish.
- C. Galvanized-Steel Sheet: ASTM A 653/A 653M, G90 zinc coating, mill phosphatized.
- D. Stainless-Steel Sheet: ASTM A 666, Type 304, with No. 4 finish.
- E. Fasteners: Same basic metal and alloy as fastened metal or 300 Series stainless steel unless otherwise indicated. Do not use metals that are incompatible with joined materials.
 - 1. Use types and sizes to suit unit installation conditions.
 - 2. Use hex-head or Phillips pan-head screws for exposed fasteners unless otherwise indicated.
- F. Post-Installed Fasteners for Concrete and Masonry: Torque-controlled expansion anchors made from stainless-steel components, with capability to sustain without failure a load equal to 4 times the loads imposed for concrete, or 6 times the load imposed for masonry, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.
- G. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.2 FABRICATION, GENERAL

- A. Factory or shop fabricate gravity ventilators to minimize field splicing and assembly. Disassemble units to the minimum extent as necessary for shipping and handling. Clearly mark units for reassembly and coordinated installation.
- B. Fabricate frames, including integral bases, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.
- C. Fabricate units with closely fitted joints and exposed connections accurately located and secured.
- D. Fabricate supports, anchorages, and accessories required for complete assembly.
- E. Perform shop welding by AWS-certified procedures and personnel.

2.3 ROOF HOODS

- A. Factory or shop fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figures 6-6 and 6-7.

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- B. Materials: Galvanized-steel sheet, minimum 0.064-inch-thick base and 0.040-inch-thick hood or aluminum sheet, minimum 0.063-inch-thick base and 0.050-inch-thick hood; suitably reinforced.
- C. Roof Curbs: Galvanized-steel sheet; with mitered and welded corners; 1-1/2-inch-thick, rigid fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to fit roof opening and ventilator base.
 - 1. Configuration: Built-in raised cant and mounting flange.
 - 2. Overall Height: 16 inches.
- D. Bird Screening: Galvanized-steel, 1/2-inch-square mesh, 0.041-inch wire or aluminum, 1/2-inch-square mesh, 0.063-inch wire.
- E. Galvanized-Steel Sheet Finish:
 - 1. Surface Preparation: Clean surfaces of dirt, grease, and other contaminants. Clean welds, mechanical connections, and abraded areas and repair galvanizing according to ASTM A 780. Apply a conversion coating suited to the organic coating to be applied over it.
 - 2. Factory Priming for Field-Painted Finish: Where field painting after installation is indicated, apply an air-dried primer immediately after cleaning and pretreating.
 - 3. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of 1 mil for topcoat and an overall minimum dry film thickness of 2 mils.
 - a. Color and Gloss: As selected by Architect from manufacturer's full range.

2.4 GOOSENECKS

- A. Factory or shop fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 6-5; with a minimum of 0.052-inch-thick, galvanized-steel sheet.
- B. Roof Curbs: Galvanized-steel sheet; with mitered and welded corners; 1-1/2-inch-thick, rigid fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to fit roof opening and ventilator base.
 - 1. Configuration: Built-in raised cant and mounting flange.
 - 2. Overall Height: 16 inches.
- C. Bird Screening: Galvanized-steel, 1/2-inch-square mesh, 0.041-inch wire or aluminum, 1/2-inch-square mesh, 0.063-inch wire.
- D. Galvanized-Steel Sheet Finish:
 - 1. Surface Preparation: Clean surfaces of dirt, grease, and other contaminants. Clean welds, mechanical connections, and abraded areas and repair galvanizing according to ASTM A 780. Apply a conversion coating suited to the organic coating to be applied over it.

2. Factory Priming for Field-Painted Finish: Where field painting after installation is indicated, apply an air-dried primer immediately after cleaning and pretreating.
3. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of 1 mil for topcoat and an overall minimum dry film thickness of 2 mils.
 - a. Color and Gloss: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install gravity ventilators level, plumb, and at indicated alignment with adjacent work.
- B. Install goosenecks on curb base where throat size exceeds 9 by 9 inches.
- C. Install gravity ventilators with clearances for service and maintenance.
- D. Install perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.
- E. Install concealed gaskets, flashings, joint fillers, and insulation as installation progresses. Comply with Section 079200 "Joint Sealants" for sealants applied during installation.
- F. Label gravity ventilators according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."
- G. Protect galvanized and nonferrous-metal surfaces from corrosion or galvanic action by applying a heavy coating of bituminous paint on surfaces that will be in contact with concrete, masonry, or dissimilar metals.
- H. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.

3.2 CONNECTIONS

- A. Duct installation and connection requirements are specified in Section 233113 "Metal Ducts." Drawings indicate general arrangement of ducts and duct accessories.

END OF SECTION

SECTION 235216 - CONDENSING BOILERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes gas-fired, condensing boilers, trim, and accessories for generating hot water.
- B. Sustainable Design Requirements: Work included in this specification shall conform to the US Green Building Council LEED requirements listed in Section 018113.23 "Sustainable Design Requirements - LEED 2009 for Schools."

1.3 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Product Data: For each type of product. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for boilers.
 - 2. Include rated capacities, operating characteristics, and furnished specialties and accessories.
- C. Sustainable Design Submittals:
 - 1. **Product Data:** For energy performance.
- D. Shop Drawings: For boilers, boiler trim, and accessories.
 - 1. Include plans, elevations, sections, and mounting and attachment details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 “Submittal Procedures” and the individual sections specifying the work.
- B. Source quality-control reports.
- C. Field quality-control reports.
- D. Sample Warranty: For special warranty.
- E. Other Informational Submittals:
 - 1. ASME Stamp Certification and Report: Submit "A," "S," or "PP" stamp certificate of authorization, as required by authorities having jurisdiction, and document hydrostatic testing of piping external to boiler.
 - 2. CSA B51 pressure vessel Canadian Registration Number (CRN).

1.5 CLOSEOUT SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 “Submittal Procedures” and the individual sections specifying the work.
- B. Operation and Maintenance Data: For boilers to include in emergency, operation, and maintenance manuals.

1.6 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Fire-Tube Condensing Boilers:
 - a. Leakage and Materials: 10 years from date of Substantial Completion.
 - b. Heat Exchanger Damaged by Thermal Stress and Corrosion: **[Prorated]** **[Nonprorated]** for **[five]** <Insert number> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASME Compliance: Fabricate and label boilers to comply with 2010 ASME Boiler and Pressure Vessel Code.

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- C. ASHRAE/IES 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."
- D. DOE Compliance: Minimum efficiency shall comply with 10 CFR 430, Subpart B, Appendix N.
- E. UL Compliance: Test boilers for compliance with UL 795. Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.
- F. CSA Compliance: Test boilers for compliance with CSA B51.

2.2 FORCED-DRAFT, FIRE-TUBE CONDENSING BOILERS

- A. 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. Water-heating service only.
- B. Heat Exchanger: Nonferrous, corrosion-resistant combustion chamber.
- C. Pressure Vessel: Carbon steel with welded heads and tube connections.
- D. Burner: Natural gas, forced draft.
- E. 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 Section 230513 "Common Motor Requirements for HVAC 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.
- F. Gas Train: Combination gas valve with manual shutoff and pressure regulator.
- G. Ignition: Spark ignition with 100 percent main-valve shutoff with electronic flame supervision.
- H. Casing:
 - 1. Jacket: Sheet metal, with snap-in or interlocking closures.
 - 2. Control Compartment Enclosures: NEMA 250, Type 1A.
 - 3. Finish: Baked-enamel or powder-coated protective finish.
 - 4. Insulation: Minimum 2-inch-thick, mineral-fiber insulation surrounding the heat exchanger.
 - 5. Combustion-Air Connections: Inlet and vent duct collars.
- I. Capacities and Characteristics: As scheduled on Drawings.

2.3 TRIM

- A. Include devices sized to comply with ASME B31.1.
- B. Aquastat Controllers: Operating, firing rate, and high limit.
- C. Safety Relief Valve: ASME rated.
- D. Pressure and Temperature Gage: Minimum 3-1/2-inch-diameter, combination water-pressure and -temperature gage. Gages shall have operating-pressure and -temperature ranges, so normal operating range is about 50 percent of full range.
- E. Boiler Air Vent: Automatic.
- F. Drain Valve: Minimum NPS 3/4 hose-end gate valve.

2.4 CONTROLS

- A. Refer to Section 230923 "Direct Digital Control (DDC) System for HVAC."
- B. Boiler operating controls shall include the following devices and features:
 - 1. Control transformer.
 - 2. Set-Point Adjust: Set points shall be adjustable.
 - 3. Sequence of Operation: Electric, factory-fabricated and field-installed panel to control burner firing rate to maintain discharge water temperature.
 - a. Include automatic, alternating-firing sequence for multiple boilers to ensure maximum system efficiency throughout the load range and to provide equal runtime for boilers.
- C. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation.
 - 1. High Cutoff: Automatic reset stops burner if operating conditions rise above maximum boiler design temperature.
 - 2. Low-Water Cutoff Switch: Electronic probe shall prevent burner operation on low water. Cutoff switch shall be manual-reset type.
 - 3. Blocked Inlet Safety Switch: Manual-reset pressure switch field mounted on boiler combustion-air inlet.
 - 4. Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for above conditions.
- D. Building Automation System Interface: Factory installed hardware and software to enable building automation system to monitor, control, and display boiler status and alarms.
 - 1. Hardwired Points:
 - a. Monitoring: On/off status, common trouble alarm.

- b. Control: On/off operation, hot-water-supply temperature set-point adjustment.
2. A communication interface with building automation system shall enable building automation system operator to remotely control and monitor the boiler from an operator workstation. Control features available, and monitoring points displayed, locally at boiler control panel shall be available through building automation system.

2.5 ELECTRICAL POWER

- A. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in electrical Sections.
- B. 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.
 1. House in NEMA 250, Type 1 enclosure.
 2. Wiring shall be numbered and color coded to match wiring diagram.
 3. Install factory wiring outside of an enclosure in a metal raceway.
 4. Field power interface shall be to circuit breaker.
 5. Provide each motor with overcurrent protection.

2.6 VENTING KITS

- A. Kit: Complete system, ASTM A 959, Type 29-4C stainless steel, pipe, vent terminal, thimble, indoor plate, vent adapter, condensate trap and dilution tank, and sealant.
- B. Combustion-Air Intake: Complete system, stainless steel, pipe, vent terminal with screen, inlet air coupling, and sealant.

2.7 SOURCE QUALITY CONTROL

- A. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.
- B. Test and inspect factory-assembled boilers, before shipping, according to 2010 ASME Boiler and Pressure Vessel Code.
- C. Allow Owner access to source quality-control testing of boilers. Notify Architect 14 days in advance of testing.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. 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.
- B. Examine mechanical spaces for suitable conditions where boilers will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 BOILER INSTALLATION

- A. Equipment Mounting:
 - 1. Install boilers on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
 - 2. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."
- B. Install gas-fired boilers according to NFPA 54.
- C. Assemble and install boiler trim.
- D. Install electrical devices furnished with boiler but not specified to be factory mounted.
- E. Install control wiring to field-mounted electrical devices.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to boiler to allow service and maintenance.
- C. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection.
- D. 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.
- E. Connect hot-water piping to supply- and return-boiler tappings with shutoff valve and union or flange at each connection.

- F. Install piping from safety relief valves to nearest floor drain.
- G. Boiler Venting:
 - 1. Install flue venting kit and combustion-air intake.
 - 2. Connect full size to boiler connections.
- H. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- I. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 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.
- C. Boiler will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.
- E. 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.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain boilers. Refer to Section 017900 "Demonstration and Training."

END OF SECTION

SECTION 236313 - AIR-COOLED CONDENSING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes packaged, air-cooled refrigerant condensers for outdoor installation.
- B. Sustainable Design Requirements: Work included in this specification shall conform to the US Green Building Council LEED requirements listed in Section 018113.23 "Sustainable Design Requirements - LEED 2009 for Schools."

1.3 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Product Data: For each air-cooled refrigerant condenser. Include rated capacities, operating characteristics, furnished specialties, and accessories. Include equipment dimensions, weights and structural loads, required clearances, method of field assembly, components, and location and size of each field connection. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.
- C. Sustainable Design Submittals:
 - 1. **Product Data:** For refrigerants.
 - 2. **Product Data:** For energy performance.
- D. Shop Drawings: For air-cooled refrigerant condensers. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.

- B. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 - 1. Structural members to which air-cooled refrigerant condensers will be attached.
 - 2. Liquid and vapor pipe sizes.
 - 3. Refrigerant specialties.
 - 4. Piping including connections, oil traps, and double risers.
 - 5. Evaporators.
- C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Operation and Maintenance Data: For air-cooled refrigerant condensers to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Fabricate and label refrigeration system according to ASHRAE 15, "Safety Standard for Refrigeration Systems."
- C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.7 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Section 033000 "Cast-in-Place Concrete."
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 077200 "Roof Accessories."
- C. Coordinate location of refrigerant piping and electrical rough-ins.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

- A. Description: Factory assembled and tested; consisting of casing, condenser coils, condenser fans and motors, and unit controls.
- B. Refrigerant: R-410A.
- C. Condenser Coil: Factory tested at 425 psig.
 - 1. Tube: Microchannel, fully brazed, aluminum construction.
 - 2. Coil Fin: Aluminum.
 - 3. Circuit: To match compressors.
- D. Condenser Fans and Drives: Propeller fans with aluminum or galvanized-steel fan blades, for vertical air discharge; directly driven with permanently lubricated ball-bearing motors with integral current- and thermal-overload protection.
 - 1. Weather-proof motors with rain shield and shaft slinger.
- E. Operating and Safety Controls: Include condenser fan motor thermal and overload cutouts; 115-V control transformer, if required; magnetic contactors for condenser fan motors and a nonfused factory-mounted and -wired disconnect switch for single external electrical power connection.
- F. Casings: Designed for outdoor installation with weather protection for components and controls, and with the following:
 - 1. Removable panels for access to controls, condenser fans, motors, and drives.
 - 2. Steel fan guards.
 - 3. Lifting eyes.
 - 4. Hail/vondal guards.
 - 5. Low ambient control.

2.2 MOTORS

- A. 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. 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.
 - 3. Mount unit-mounted disconnect switches on exterior of unit.

2.3 SOURCE QUALITY CONTROL

- A. Verification of Performance: Rate air-cooled refrigerant condensers according to ARI 460.
- B. Testing Requirements: Factory test sound-power-level ratings according to ARI 270.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of air-cooled refrigerant condensers.
- B. Examine roughing-in for refrigerant piping systems to verify actual locations of piping connections before equipment installation.
- C. Examine walls, floors, and roofs for suitable conditions where air-cooled condensers will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install units level and plumb, firmly anchored in locations indicated; maintain manufacturer's recommended clearances.
- B. Equipment Mounting:
 - 1. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."
- C. Maintain manufacturer's recommended clearances for service and maintenance.
- D. Loose Components: Install electrical components, devices, and accessories that are not factory mounted.

3.3 CONNECTIONS

- A. Install piping adjacent to machine to allow service and maintenance.

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
 1. Perform electrical test and visual and mechanical inspection.
 2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Complete manufacturer's starting checklist.
 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 5. Verify proper airflow over coils.
- C. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.
- D. Air-cooled condensing units will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.

3.5 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 1. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
 - a. Inspect for physical damage to unit casing.
 - b. Verify that access doors move freely and are weathertight.
 - c. Clean units and inspect for construction debris.
 - d. Verify that all bolts and screws are tight.
 - e. Adjust vibration isolation and flexible connections.
 - f. Verify that controls are connected and operational.
 2. Lubricate bearings on fan motors.
 3. Verify that fan wheel is rotating in the correct direction and is not vibrating or binding.
 4. Start unit according to manufacturer's written instructions and complete manufacturer's startup checklist.
 5. Measure and record airflow and air temperature rise over coils.
 6. Verify proper operation of capacity control device.
 7. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.
 8. After startup and performance test, lubricate bearings.

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3.6 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain air-cooled refrigerant condensers.

END OF SECTION

SECTION 237313 - MODULAR INDOOR CENTRAL-STATION AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Constant-air-volume air-handling units.
 - 2. Variable-air-volume air-handling units.
- B. Sustainable Design Requirements: Work included in this specification shall conform to the US Green Building Council LEED requirements listed in Section 018113.23 "Sustainable Design Requirements - LEED 2009 for Schools."

1.3 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Product Data: For each air-handling unit indicated. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.
 - 1. Unit dimensions and weight.
 - 2. Cabinet material, metal thickness, finishes, insulation, and accessories.
 - 3. Fans:
 - a. Certified fan-performance curves with system operating conditions indicated.
 - b. Certified fan-sound power ratings.
 - c. Fan construction and accessories.
 - d. Motor ratings, electrical characteristics, and motor accessories.
 - 4. Certified coil-performance ratings with system operating conditions indicated.
 - 5. Dampers, including housings, linkages, and operators.
 - 6. Filters with performance characteristics.
- C. Sustainable Design Submittals:
 - 1. Product data showing compliance with ASHRAE 62.1.

1.4 INFORMATIONAL SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Coordination Drawings: Floor plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Mechanical-room layout and relationships between components and adjacent structural and mechanical elements.
 - 2. Support location, type, and weight.
 - 3. Field measurements.
- C. Source quality-control reports.
- D. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Operation and Maintenance Data: For air-handling units to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. 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 for each air-handling unit.
 - 2. Fan Belts: One set for each air-handling unit fan.

1.7 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. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.
- C. AHRI Certification: Air-handling units and their components shall be factory tested according to AHRI 430, "Performance Rating of Central-Station Air-Handling Unit Supply Fans," and shall be listed and labeled by AHRI.

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- D. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- E. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- F. Comply with NFPA 70.

1.8 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.
- B. Coordinate sizes and locations of structural-steel support members, if any, with actual equipment provided.

PART 2 - PRODUCTS

2.1 UNIT CASINGS

- A. General Fabrication Requirements for Casings:
 - 1. Forming: Double-walled walls, roofs, and floors with at least two breaks at each joint.
 - 2. Casing Joints: Sheet metal screws or pop rivets.
 - 3. Sealing: Seal all joints with water-resistant sealant.
 - 4. Casing Coating: Hot-dip galvanized.
 - 5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- B. Casing Insulation and Adhesive:
 - 1. Materials: ASTM C 1071.
 - 2. Location and Application: Encased between outside and inside casing.
- C. Inspection and Access Panels and Access Doors:
 - 1. Panel and Door Fabrication: Formed and reinforced, double-wall and insulated panels of same materials and thicknesses as casing.
 - 2. Inspection and Access Panels:
 - a. Fasteners: Two or more camlock type for panel lift-out operation. Arrangement shall allow panels to be opened against air-pressure differential.
 - b. Gasket: Neoprene, applied around entire perimeters of panel frames.
 - c. Size: Large enough to allow inspection and maintenance of air-handling unit's internal components.
 - 3. Access Doors:

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- a. Hinges: A minimum of two ball-bearing hinges or stainless-steel piano hinge and two wedge-lever-type latches, operable from inside and outside. Arrange doors to be opened against air-pressure differential.
 - b. Gasket: Neoprene, applied around entire perimeters of panel frames.
 - c. Fabricate windows in fan section doors of double-glazed, wire-reinforced safety glass with an air space between panes and sealed with interior and exterior rubber seals.
 - d. Size: At least 24 inches wide by full height of unit casing up to a maximum height of 60 inches.
4. Locations and Applications:
- a. Fan Section: Doors.
 - b. Access Section: Doors.
 - c. Coil Section: Inspection and access panel.
 - d. Damper Section: Doors.
 - e. Filter Section: Doors large enough to allow periodic removal and installation of filters.
 - f. Mixing Section: Doors.
5. Service Light: 100-W vaporproof fixture with switched junction box located outside adjacent to door.
- a. Locations: Each section accessed with door.
- D. Condensate Drain Pans:
1. Fabricated with two percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and from humidifiers and to direct water toward drain connection.
 - a. Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
 - b. Depth: A minimum of 2 inches deep.
 2. Double-wall, stainless-steel sheet with space between walls filled with foam insulation and moisture-tight seal.
 3. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on both ends of pan.
 - a. Minimum Connection Size: NPS 1.
 4. Pan-Top Surface Coating: Asphaltic waterproofing compound.
 5. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.
- E. Air-Handling-Unit Mounting Frame: Formed galvanized-steel channel or structural channel supports, designed for low deflection, welded with integral lifting lugs.

2.2 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: Designed for continuous operation at maximum-rated fan speed and motor horsepower, and 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 3-1/2 inches wide attached to 2 strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized-steel sheet or 0.032-inch- thick aluminum sheets; select metal compatible with casing.
 - a. Flexible Connector Fabric: Glass fabric, double coated with neoprene. Fabrics, coatings, and adhesives shall comply with UL 181, Class 1.
 - 1) Fabric Minimum Weight: 26 oz./sq. yd..
 - 2) Fabric Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
 - 3) Fabric Service Temperature: Minus 40 to plus 200 deg F.
- C. Plenum Fan Housings: Steel frame and panel; fabricated without fan scroll and volute housing.
- D. Backward-Inclined, Centrifugal Fan Wheels: Single-width-single-inlet and double-width-double-inlet construction with curved inlet flange, backplate, backward-inclined blades welded or riveted to flange and backplate; cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws.
- E. 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; cast-steel hub swaged to backplate and fastened to shaft with set screws.
- F. Airfoil, Centrifugal Fan Wheels: Smooth-curved inlet flange, backplate, and hollow die-formed airfoil-shaped blades continuously welded at tip flange and backplate; cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws.
- G. Fan Shaft Bearings:

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1. Prelubricated and Sealed, Ball Bearings: Self-aligning, pillow-block type with a rated life of 120,000 hours according to ABMA 9.
- H. Belt Drives: Factory mounted, with adjustable alignment and belt tensioning, and with 1.3 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, nonsparking, and nonstatic; 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"; 0.1046-inch- thick, 3/4-inch diamond-mesh wire screen, welded to steel angle frame; prime coated.
- I. Internal Vibration Isolation: Fans shall be factory mounted with manufacturer's standard restrained vibration isolation mounting devices having a minimum static deflection of 1 inch.
- J. 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 (TM) 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.
- K. Variable Frequency Controllers:
1. Description: NEMA ICS 2, IGBT, PWM, VFC; listed and labeled as a complete unit and arranged to provide variable speed of an NEMA MG 1, Design B, 3-phase induction motor by adjusting output voltage and frequency.
 2. Output Rating: 3-phase; 6 to 120 Hz, with horsepower constant throughout speed range.
 3. Unit Operating Requirements:
 - a. Input ac voltage tolerance of 380 to 500 V, plus or minus 10 percent.
 - b. Input frequency tolerance of 06/11 Hz, plus or minus 6 percent.
 - c. Minimum Efficiency: 96 percent at 60 Hz, full load.
 - d. Minimum Displacement Primary-Side Power Factor: 96 percent.
 - e. Overload Capability: 1.1 times the base load current for 60 seconds; 2.0 times the base load current for 3 seconds.
 - f. Starting Torque: 100 percent of rated torque or as indicated.
 - g. Speed Regulation: Plus or minus 1 percent.

4. Isolated control interface to allow controller to follow control signal over an 11:1 speed range.
5. Internal Adjustability Capabilities:
 - a. Minimum Speed: 5 to 25 percent of maximum rpm.
 - b. Maximum Speed: 80 to 100 percent of maximum rpm.
 - c. Acceleration: 2 to a minimum of 22 seconds.
 - d. Deceleration: 2 to a minimum of 22 seconds.
 - e. Current Limit: 50 to a minimum of 110 percent of maximum rating.
6. Self-Protection and Reliability Features:
 - a. Input transient protection by means of surge protection device (SPD).
 - b. Undervoltage and overvoltage trips; inverter overtemperature, overload, and overcurrent trips.
 - c. Adjustable motor overload relays capable of NEMA ICS 2, performance.
 - d. Notch filter to prevent operation of the controller-motor-load combination at a natural frequency of the combination.
 - e. Instantaneous line-to-line and line-to-ground overcurrent trips.
 - f. Loss-of-phase protection.
 - g. Reverse-phase protection.
 - h. Short-circuit protection.
 - i. Motor overtemperature fault.
7. Automatic Reset/Restart: Attempts three restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Bidirectional autospeed search shall be capable of starting into rotating loads spinning in either direction and returning motor to set speed in proper direction, without damage to controller, motor, or load.
8. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped.
9. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.
10. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.
11. Meters or digital readout devices and selector switch, mounted flush in controller door and connected to indicate the following controller parameters:
 - a. Output frequency (Hertz).
 - b. Motor speed (rpm).
 - c. Motor status (running, stop, fault).
 - d. Motor current (amperes).
 - e. Motor torque (percent).
 - f. Fault or alarming status (code).
 - g. Proportional-integral-derivative (PID) feedback signal (percent).
 - h. DC-link voltage (volts direct current).
 - i. Set-point frequency (Hertz).
 - j. Motor output voltage (volts).

12. Control Signal Interface:
 - a. Electric Input Signal Interface: A minimum of 2 analog inputs (0 to 10 V or 0/4-20 mA) and 6 programmable digital inputs.
 - b. Remote signal inputs capable of accepting any of the following speed-setting input signals from the control system:
 - 1) 0 to 10-V dc.
 - 2) 0-20 or 4-20 mA.
 - 3) Potentiometer using up/down digital inputs.
 - 4) Fixed frequencies using digital inputs.
 - 5) RS485.
 - 6) Keypad display for local hand operation.
 - c. Output signal interface with a minimum of 1 analog output signal (0/4-20 mA), which can be programmed to any of the following:
 - 1) Output frequency (Hertz).
 - 2) Output current (load).
 - 3) DC-link voltage (volts direct current).
 - 4) Motor torque (percent).
 - 5) Motor speed (rpm).
 - 6) Set-point frequency (Hertz).
 - d. Remote indication interface with a minimum of 2 dry circuit relay outputs (120-V ac, 1 A) for remote indication of the following:
 - 1) Motor running.
 - 2) Set-point speed reached.
 - 3) Fault and warning indication (overtemperature or overcurrent).
 - 4) High- or low-speed limits reached.
13. Communications: Full BACnet compatibility.
14. Integral Disconnecting Means: NEMA AB 1, instantaneous-trip circuit breaker with lockable handle.
15. Accessories:
 - a. Devices shall be factory installed in controller enclosure unless otherwise indicated.
 - b. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.
 - c. Standard Displays:
 - 1) Output frequency (Hertz).
 - 2) Set-point frequency (Hertz).
 - 3) Motor current (amperes).
 - 4) DC-link voltage (volts direct current).
 - 5) Motor torque (percent).
 - 6) Motor speed (rpm).
 - 7) Motor output voltage (volts).

2.3 COIL SECTION

A. General Requirements for Coil Section:

1. Comply with AHRI 410.
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.

2.4 AIR FILTRATION SECTION

A. General Requirements for Air Filtration Section:

1. Comply with NFPA 90A.
2. Provide minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
3. Provide filter holding frames arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.

B. Extended-Surface, Disposable Panel Filters:

1. Factory-fabricated, dry, extended-surface type.
2. Thickness: 1 inch.
3. MERV (ASHRAE 52.2): 7.
4. Media: Fibrous material formed into deep-V-shaped pleats with antimicrobial agent and held by self-supporting wire grid.
5. Media-Grid Frame: Nonflammable cardboard.
6. Mounting Frames: Welded, galvanized steel, with gaskets and fasteners, suitable for bolting together into built-up filter banks.

C. Extended-Surface, Nonsupported-Media Filters:

1. Factory-fabricated, dry, extended-surface, self-supporting type.
2. MERV (ASHRAE 52.2): 13.
3. Media: Fibrous material with antimicrobial agent constructed so individual pleats are maintained in tapered form by flexible internal supports under rated-airflow conditions.
4. Filter-Media Frame: Galvanized steel.
5. Mounting Frames: Welded, galvanized steel, with gaskets and fasteners, suitable for bolting together into built-up filter banks with space for prefilter.

D. Filter Gage:

1. 3-1/2-inch-diameter, diaphragm-actuated dial in metal case.
2. Vent valves.
3. Black figures on white background.
4. Front recalibration adjustment.
5. 2 percent of full-scale accuracy.
6. Range: 0- to 2.0-inch wg.

7. Accessories: Static-pressure tips with integral compression fittings, 1/4-inch tubing, and 2- or 3-way vent valves.

2.5 DAMPERS

- A. General Requirements for Dampers: Leakage rate, according to AMCA 500, "Laboratory Methods for Testing Dampers for Rating," shall not exceed 2 percent of air quantity at 2000-fpm face velocity through damper and 4-inch wg pressure differential.
- B. Damper Operators: Comply with requirements in Section 230923.12 "Control Dampers."

2.6 AIR-TO-AIR ENERGY RECOVERY

- A. Heat Wheels:
 1. Casing:
 - a. Steel, with manufacturer's standard paint coating.
 - 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 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: Polymer segmented wheel, strengthened with radial spokes impregnated with nonmigrating, water-selective, molecular-sieve desiccant coating. Construct media for passing maximum [800] [1200]-micrometer solids.
 3. Drive: Fractional horsepower motor and gear reducer, with speed changed by variable frequency controller, and self-adjusting multilink belt around outside of rotor.
 4. Controls:
 - a. Variable frequency controller, factory mounted and wired, permitting input of field connected 4-20 mA or 1-10-V control signal.
 - b. Pilot-Light Indicator: Display rotor rotation and speed.
 - c. Speed Settings: Adjustable settings for maximum and minimum rotor speed limits.

2.7 CAPACITIES AND CHARACTERISTICS

- A. As scheduled on the Drawings.

2.8 SOURCE QUALITY CONTROL

- A. 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, "Reverberant Room Method for Sound Testing of Fans." Fans shall bear AMCA-certified sound ratings seal.

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- B. 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."
- C. Water Coils: Factory tested to 300 psig according to AHRI 410 and ASHRAE 33.
- D. Refrigerant Coils: Factory tested to 450 psig according to AHRI 410 and ASHRAE 33.

PART 3 - EXECUTION

3.1 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 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.

3.2 INSTALLATION

- A. Equipment Mounting:
 - 1. Install air-handling units on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
 - 2. Comply with requirements for vibration isolation 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-gage, static-pressure taps upstream and downstream of filters. Mount filter gages on outside of filter housing or filter plenum in accessible position. Provide filter gages on filter banks, installed with separate static-pressure taps upstream and downstream of filters.

3.3 CONNECTIONS

- A. Comply with requirements for piping specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

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- B. Install piping adjacent to air-handling unit to allow service and maintenance.
- C. Connect piping to air-handling units mounted on vibration isolators with flexible connectors.
- D. Connect condensate drain pans using ASTM B 88, Type M copper tubing. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.
- E. Hot- and Chilled-Water Piping: Comply with applicable requirements in Section 232113 "Hydronic Piping" and Section 232116 "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.
- F. Refrigerant Piping: Comply with applicable requirements in Section 232300 "Refrigerant Piping." Install shutoff valve and union or flange at each supply and return connection.
- G. Connect duct to air-handling units with flexible connections. Comply with requirements in Section 233300 "Air Duct Accessories."

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections.
- C. Tests and Inspections:
 - 1. Leak Test: After installation, fill water coils with water, and test coils and connections for leaks.
 - 2. Charge refrigerant coils with refrigerant and test for leaks.
 - 3. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 4. HEPA-Filter Operational Test: Pressurize housing to a minimum of 3-inch wg or to designed operating pressure, whichever is higher; test housing joints, door seals, and sealing edges of filter for air leaks according to ASME N510, pressure-decay method.
 - 5. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Air-handling unit or components will be considered defective if unit or components do not pass tests and inspections.
- E. Prepare test and inspection reports.

3.5 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. 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 zone dampers fully open and close for each zone.
7. Verify that face-and-bypass dampers provide full face flow.
8. Verify that outdoor- and return-air mixing dampers open and close, and maintain minimum outdoor-air setting.
9. Comb coil fins for parallel orientation.
10. Verify that proper thermal-overload protection is installed for electric coils.
11. Install new, clean filters.
12. 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 and sheaves 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.

3.6 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for air-handling system testing, adjusting, and balancing.

3.7 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.

3.8 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-handling units.

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END OF SECTION

SECTION 237423.16 - PACKAGED, INDIRECT-FIRED, OUTDOOR, HEATING-ONLY MAKEUP-AIR UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes indirect-fired makeup-air units.
- B. Sustainable Design Requirements: Work included in this specification shall conform to the US Green Building Council LEED requirements listed in Section 018113.23 "Sustainable Design Requirements - LEED 2009 for Schools."

1.3 DEFINITIONS

- A. DDC: Direct digital control.

1.4 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Product Data: For each type and configuration of outdoor, indirect-fired makeup-air unit. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.
 - 1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- C. Sustainable Design Submittals:
 - 1. **Product Data:** For ventilation equipment, indicating compliance with ASHRAE 62.1, Section 5 - "Systems and Equipment."
- D. Shop Drawings: For each type and configuration of outdoor, indirect-fired heating and ventilating unit.
 - 1. Signed, sealed, and prepared by or under the supervision of a qualified professional engineer.
 - 2. Include plans, elevations, sections, and mounting and attachment details.

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3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
4. Detail fabrication and assembly of gas-fired heating and ventilating units, as well as procedures and diagrams.
5. Design Calculations: Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.
6. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.
7. Include diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Startup service reports.
- C. Sample Warranty: For manufacturer's special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Operation and Maintenance Data: For indirect-fired makeup-air units to include in emergency, operation, and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Filters: One set for each unit.
 2. Fan Belts: One set for each unit.

1.8 QUALITY ASSURANCE

- A. Comply with NFPA 70.
- B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.9 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of indirect-fired heating and ventilating units that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Heat Exchangers: Manufacturer's standard, but not less than 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Factory-assembled, prewired, self-contained unit consisting of cabinet, supply fan, controls, filters, and indirect-fired gas burner to be installed exterior to the building.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 UNIT CASINGS

- A. General Fabrication Requirements for Casings:
 - 1. Forming: Form walls, roofs, and floors with at least two breaks at each joint.
 - 2. Casing Joints: Sheet metal screws or pop rivets, factory sealed with water-resistant sealant.
 - 3. Factory Finish for Steel and Galvanized-Steel Casings: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-on enamel finish, consisting of prime coat and thermosetting topcoat.
 - 4. Air-Handling-Unit Mounting Frame: Formed galvanized-steel channel or structural channel supports, designed for low deflection, welded with integral lifting lugs.
 - 5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- B. Configuration: Horizontal unit with bottom discharge for roof-mounting installation.
- C. Cabinet: Galvanized-steel panels, formed to ensure rigidity and supported by galvanized-steel channels or structural channel supports with lifting lugs. Duct flanges at inlet and outlet. Knockouts with grommet seals for electrical and piping connections and lifting lugs.
- D. Inner Casing:
 - 1. Burner Section Inner Casing: 0.0299-inch- thick steel.
 - 2. Double-wall casing with inner wall of steel.
 - 3. Internal Insulation: Fibrous-glass duct lining, neoprene coated, comply with ASTM C 1071, Type II, applied on complete unit.
 - a. Thickness: 2 inches.

- b. Insulation Adhesive: Comply with ASTM C 916, Type I.
 - c. Density: 1.5 lb/cu. ft.
 - d. Mechanical Fasteners: Galvanized steel suitable for adhesive, mechanical, or welding attachment to casing without damaging liner when applied as recommended by manufacturer and without causing air leakage.
- E. Inspection and Access Panels and Access Doors:
- 1. Panel and Door Fabrication: Formed and reinforced, double-wall and insulated panels of same materials and thicknesses as casing.
 - 2. Inspection and Access Panels:
 - a. Fasteners: Two or more camlock type for panel lift-out operation. Arrangement shall allow panels to be opened against air-pressure differential.
 - b. Gasket: Neoprene, applied around entire perimeters of panel frames.
 - c. Size: Large enough to allow inspection and maintenance of air-handling unit's internal components.
 - 3. Access Doors:
 - a. Hinges: A minimum of two ball-bearing hinges or stainless-steel piano hinge and two wedge-lever-type latches, operable from inside and outside. Arrange doors to be opened against air-pressure differential.
 - b. Gasket: Neoprene, applied around entire perimeters of panel frames.
 - 4. Locations and Applications:
 - a. Fan Section: Doors.
 - b. Access Section: Doors.
 - c. Coil Section: Inspection and access panels.
 - d. Damper Section: Doors.
 - e. Filter Section: Doors large enough to allow periodic removal and installation of filters.
 - 5. Service Light: 100-W vaporproof fixture with switched junction box located inside adjacent to door.
 - a. Locations: Each section accessed with door.
- F. Condensate Drain Pans:
- 1. Fabricated with two percent slope in at least two planes to collect condensate from condensate-producing heat exchangers, and to direct water toward drain connection.
 - a. Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
 - b. Depth: A minimum of 2 inches deep.
 - 2. Double-wall, stainless-steel sheet with space between walls filled with foam insulation and moisture-tight seal.

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3. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on both ends of pan.
 - a. Minimum Connection Size: NPS 1.
4. Pan-Top Surface Coating: Asphaltic waterproofing compound.

2.3 ACCESSORIES

- A. Duplex, 115-V, ground-fault-interrupter outlet with 15-A overcurrent protection. Include transformer if required. Outlet shall be energized even if the unit main disconnect is open.

2.4 OUTDOOR-AIR INTAKE HOOD

- A. Type: Manufacturer's standard hood or louver.
- B. Materials: Match cabinet.
- C. Bird Screen: Comply with requirements in ASHRAE 62.1.
- D. Filter: Aluminum, 1 inch cleanable.
- E. Configuration: Designed to inhibit wind-driven rain and snow from entering unit.

2.5 ROOF CURBS

- A. Materials: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailer; complying with NRCA standards.
 1. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
 - a. Materials: ASTM C 1071, Type I or Type II.
 - b. Thickness: 2 inches.
 2. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.
 - a. Liner Adhesive: Comply with ASTM C 916, Type I.
 - b. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
 - c. Liner materials applied in this location shall have air-stream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service air velocity.
 - d. Liner Adhesive: Comply with ASTM C 916, Type I.
- B. Curb Height: 24 inches.

2.6 SUPPLY-AIR FAN

- A. Fan Type: Centrifugal, rated according to AMCA 210; statically and dynamically balanced, galvanized steel; mounted on solid-steel shaft with heavy-duty, self-aligning, permanently lubricated ball bearings. Bearing rating: L10 of 120,000 hours.
- B. Drive: V-belt drive with matching fan pulley and adjustable motor sheaves and belt assembly.
- C. Mounting: Fan wheel, motor, and drives shall be mounted in fan casing with restrained, spring isolators.
- D. Fan-Shaft Lubrication Lines: Extended to a location outside the casing.

2.7 AIR FILTERS

- A. Comply with NFPA 90A.
- B. Disposable Panel Filters: Factory-fabricated, flat-panel-type, disposable air filters with holding frames, with a MERV 6 according to ASHRAE 52.2.
 - 1. Thickness: 2 inches.
 - 2. Media: Interlaced glass or polyester fibers.
 - 3. Frame: Galvanized steel.

2.8 DAMPERS

- A. Outdoor-Air Damper: Galvanized-steel, opposed-blade dampers with vinyl blade seals and stainless-steel jamb seals, having a maximum leakage of 10 cfm/sq. ft. of damper area, at a differential pressure of 2-inch wg.
- B. Damper Operator: Direct coupled, electronic with spring return or fully modulating as required by the control sequence.

2.9 INDIRECT-FIRED GAS BURNER

- A. Description: Factory assembled, piped, and wired; and complying with ANSI Z21.47, "Gas-Fired Central Furnaces," and with NFPA 54, "National Fuel Gas Code."
 - 1. CSA Approval: Designed and certified by and bearing label of CSA.
 - 2. Burners: Stainless steel.
 - a. Gas Control Valve: Modulating.
 - b. Fuel: Natural gas.
 - c. Minimum Combustion Efficiency: 80 percent.
 - d. Ignition: Electronically controlled electric spark with flame sensor.
- B. Venting: Power vented, with integral, motorized centrifugal fan interlocked with gas valve.

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- C. Combustion-Air Intake: Separate combustion-air intake and vent terminal assembly.
- D. Heat Exchanger: Stainless steel.
- E. Heat-Exchanger Drain Pan: Stainless steel.
- F. Safety Controls:
 - 1. Vent Flow Verification: Differential pressure switch to verify open vent and flame rollout switch.
 - 2. Control Transformer: 24-V ac.
 - 3. High Limit: Thermal switch or fuse to stop burner.
 - 4. Gas Train: Regulated, redundant, 24-V ac gas valve assembly containing pilot solenoid valve, electronic-modulating temperature control valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff all in one body.
 - 5. Purge-period timer shall automatically delay burner ignition and bypass low-limit control.
 - 6. Gas Manifold: Safety switches and controls complying with ANSI standards.
 - 7. Airflow Proving Switch: Differential pressure switch senses correct airflow before energizing pilot.
 - 8. Automatic-Reset, High-Limit Control Device: Stops burner and closes main gas valve if high-limit temperature is exceeded.
 - 9. Safety Lockout Switch: Locks out ignition sequence if burner fails to light after three tries. Controls are reset manually by turning the unit off and on.

2.10 UNIT CONTROL PANEL

- A. Factory-wired, fuse-protected control transformer, connection for power supply and field-wired unit to remote control panel.
- B. Control Panel: Recessed, with trim ring, remote panel, with engraved plastic cover and the following lights and switches:
 - 1. On-off-auto fan switch.
 - 2. Heat-vent-off switch.
 - 3. Supply-fan operation indicating light.
 - 4. Heating operation indicating light.
 - 5. Thermostat.
 - 6. Damper position potentiometer.
 - 7. Dirty-filter indicating light operated by unit-mounted differential pressure switch.
 - 8. Safety-lockout indicating light.
 - 9. Enclosure: NEMA 250, Type 1.

2.11 CONTROLS

- A. Comply with requirements in Section 230923 "Direct Digital Control (DDC) System for HVAC" for control equipment and sequence of operation.

- B. Interface with DDC System for HVAC: Factory-installed hardware and software to enable the DDC system for HVAC to monitor, control, and display status and alarms of heating and ventilating unit.
 - 1. Hardwired Points:
 - a. Room temperature.
 - b. Discharge-air temperature.
 - c. Burner operating.
 - 2. ASHRAE 135.1 (BACnet) communication interface with the DDC system for HVAC shall enable the DDC system for HVAC operator to remotely control and monitor the heating and ventilating unit from an operator workstation. Control features and monitoring points displayed locally at heating and ventilating unit control panel shall be available through the DDC system for HVAC.

2.12 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - 1. Enclosure: Open, dripproof.
 - 2. Efficiency: Premium efficient.

PART 3 - EXECUTION

3.1 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 roughing-in for piping, ducts, and electrical systems to verify actual locations of connections before equipment installation.
- C. Verify cleanliness of airflow path to include inner-casing surfaces, filters, coils, turning vanes, fan wheels, and other components.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Equipment Mounting:
 - 1. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

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- B. Unit Support: Install heating and ventilating unit level on structural curbs. Coordinate penetrations and flashing with wall construction.
- C. Install gas-fired units according to NFPA 54, "National Fuel Gas Code."
- D. Install controls and equipment shipped by manufacturer for field installation with indirect-fired heating and ventilating units.
- E. Roof Curb: Install on roof structure, level and secure, according to NRCA's "Low-Slope Membrane Roofing Construction Details Manual," Illustration "Raised Curb Detail for Rooftop Air Handling Units and Ducts." Install units on curbs and coordinate roof penetrations and flashing with roof construction specified in Section 077200 "Roof Accessories." Secure units to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts.

3.3 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
 - 1. Gas Piping: Comply with requirements in Section 231123 "Facility Natural-Gas Piping." Connect gas piping with shutoff valve and union, and with sufficient clearance for burner removal and service. Make final connections of gas piping to unit with corrugated, stainless-steel tubing flexible connectors complying with ANSI LC 1/CSA 6.26 equipment connections.
- B. Drain: Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for traps and accessories on piping connections to condensate drain pans under condensing heat exchangers. Where installing piping adjacent to heating and ventilating units, allow space for service and maintenance.
- C. Duct Connections: Connect supply ducts to indirect-fired heating and ventilating units with flexible duct connectors. Comply with requirements in Section 233300 "Air Duct Accessories" for flexible duct connectors.
- D. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- E. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections with the assistance of a factory-authorized service representative.
- C. Units will be considered defective if they do not pass tests and inspections.

- D. Prepare test and inspection reports.

3.5 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
- B. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
 - 1. Inspect for visible damage to burner combustion chamber.
 - 2. Inspect casing insulation for integrity, moisture content, and adhesion.
 - 3. Verify that clearances have been provided for servicing.
 - 4. Verify that controls are connected and operable.
 - 5. Verify that filters are installed.
 - 6. Purge gas line.
 - 7. Inspect and adjust vibration isolators.
 - 8. Verify bearing lubrication.
 - 9. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
 - 10. Adjust fan belts to proper alignment and tension.
- C. Start unit according to manufacturer's written instructions.
 - 1. Complete startup sheets and attach copy with Contractor's startup report.
 - 2. Inspect and record performance of interlocks and protective devices; verify sequences.
 - 3. Operate unit for run-in period recommended by manufacturer.
 - 4. Perform the following operations for both minimum and maximum firing, and adjust burner for peak efficiency:
 - a. Measure gas pressure at manifold.
 - b. Measure combustion-air temperature at inlet to combustion chamber.
 - c. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.
 - 5. Calibrate thermostats.
 - 6. Adjust and inspect high-temperature limits.
 - 7. Inspect dampers, if any, for proper stroke and interlock with return-air dampers.
 - 8. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.
 - 9. Measure and record airflow. Plot fan volumes on fan curve.
 - 10. Verify operation of remote panel, including pilot-operation and failure modes. Inspect the following:
 - a. High-limit heat.
 - b. Alarms.
 - 11. After startup and performance testing, change filters, verify bearing lubrication, and adjust belt tension.
 - 12. Verify drain-pan performance.

13. Verify outdoor-air damper operation.

3.6 ADJUSTING

- A. Adjust initial temperature set points.
- B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- C. Occupancy Adjustments: When requested within 12 months from 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.

3.7 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain heating and ventilating units.

END OF SECTION

SECTION 238126 - SPLIT-SYSTEM AIR-CONDITIONERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes split-system air-conditioning and heat-pump units consisting of separate evaporator-fan and compressor-condenser components.
- B. Sustainable Design Requirements: Work included in this specification shall conform to the US Green Building Council LEED requirements listed in Section 018113.23 "Sustainable Design Requirements - LEED 2009 for Schools."

1.3 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.
- C. Sustainable Design Submittals:
 - 1. Product Data: For refrigerants.
 - 2. Product Data: For energy performance.
- D. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.

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- B. Field quality-control reports.
- C. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. 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) for each air-handling unit.

1.7 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. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Procedures," and Section 7 - "Construction and System Start-up."
- C. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1.

1.8 COORDINATION

- A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.9 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.

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1. Warranty Period:
 - a. For Compressor: Five year(s) from date of Substantial Completion.
 - b. For Parts: Five year(s) from date of Substantial Completion.
 - c. For Labor: Five year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 INDOOR UNITS (5 TONS OR LESS)

A. Wall-Mounted, Evaporator-Fan Components:

1. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect, and discharge drain pans with drain connection.
2. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 206/110.
3. Fan: Direct drive, centrifugal.
4. Fan Motors:
 - a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
 - c. Enclosure Type: Totally enclosed, fan cooled.
 - d. NEMA Premium (TM) efficient motors as defined in NEMA MG 1.
 - e. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
6. Condensate Drain Pans:
 - a. Fabricated with slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.
 - 1) Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
 - 2) Depth: A minimum of 1 inch deep.
 - b. Double-wall, galvanized or stainless-steel sheet with space between walls filled with foam insulation and moisture-tight seal.
 - c. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on end of pan.
 - d. Pan-Top Surface Coating: Asphaltic waterproofing compound.
7. Air Filtration Section:

a. General Requirements for Air Filtration Section:

- 1) Comply with NFPA 90A.
- 2) Filter-Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.

b. Disposable Panel Filters:

- 1) Factory-fabricated, viscous-coated, flat-panel type.
- 2) Thickness: 1 inch.
- 3) Media: Interlaced glass fibers sprayed with nonflammable adhesive and antimicrobial agent.
- 4) Frame: Galvanized steel, with metal grid on outlet side, steel rod grid on inlet side, and hinged; with pull and retaining handles.

2.2 OUTDOOR UNITS (5 TONS OR LESS)

A. Air-Cooled, Compressor-Condenser Components:

1. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
 - a. Compressor Type: DC inverter-driven twin rotary.
 - b. Refrigerant: R-410A.
 - c. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 206/110.
3. Fan: Aluminum-propeller type, directly connected to motor.
4. Motor: Permanently lubricated, with integral thermal-overload protection.
5. Low Ambient Kit: Permits operation down to 0 deg F.

2.3 ACCESSORIES

A. Thermostat: Low voltage with subbase to control compressor and evaporator fan, with the following features:

1. Compressor time delay.
2. 24-hour time control of system stop and start.
3. Liquid-crystal display indicating temperature, set-point temperature, time setting, operating mode, and fan speed.
4. Fan-speed selection including auto setting.

B. Automatic-reset timer to prevent rapid cycling of compressor.

- C. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.
- D. Drain Hose: For condensate.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install units level and plumb.
- B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.
- C. Install roof-mounted, compressor-condenser components on equipment supports specified in Section 077200 "Roof Accessories." Anchor units to supports with removable, cadmium-plated fasteners.
- D. Equipment Mounting:
 - 1. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."
- E. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.

3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, start-up, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections.
- C. Tests and Inspections:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Remove and replace malfunctioning units and retest as specified above.

E. Prepare test and inspection reports.

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

3.5 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION

SECTION 238316 - RADIANT-HEATING HYDRONIC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes radiant-heating piping, including:
 - 1. PEX pipe and fittings
 - 2. Distribution manifolds
 - 3. Piping specialties

1.3 DEFINITIONS

- A. CWP: Cold working pressure.
- B. PEX: Crosslinked polyethylene.
- C. PTFE: Polytetrafluoroethylene plastic.

1.4 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Product Data: For each type of product. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.
 - 1. Include data for piping, fittings, manifolds, specialties, and controls; include pressure and temperature ratings, oxygen-barrier performance, fire-performance characteristics, and water-flow and pressure-drop characteristics.
- C. Shop Drawings: Show piping layout and details drawn to scale, including valves, manifolds, controls, and support assemblies, and their attachments to building structure.

1.5 INFORMATIONAL SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.

- B. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Suspended ceiling components.
 - 2. Structural members to which radiant-heating piping will be attached.
 - 3. Perimeter moldings.
 - 4. Flooring structure and system.
 - 5. Wall construction.
 - 6. Piping and ductwork.

1.6 CLOSEOUT SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 “Submittal Procedures” and the individual sections specifying the work.
- B. Operation and Maintenance Data: For radiant-heating piping valves and equipment to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 PEX PIPE AND FITTINGS

- A. Pipe Material: PEX plastic according to ASTM F 876.
- B. Oxygen Barrier: Limit oxygen diffusion through the tube to maximum 0.10 mg per cu. m/day at 104 deg F according to DIN 4726.
- C. Fittings: ASTM F 1807, metal insert and copper crimp rings or ASTM F 1960, cold expansion fittings and reinforcing rings.
- D. Pressure/Temperature Rating: Minimum 100 psig and 180 deg F.

2.2 DISTRIBUTION MANIFOLDS

- A. Manifold: Minimum NPS 1, brass, copper, or stainless steel.
- B. Main Shutoff Valves:
 - 1. Factory installed on supply and return connections.
 - 2. Two-piece body.
 - 3. Body: Brass or bronze.
 - 4. Ball: Chrome-plated bronze.
 - 5. Seals: PTFE.
 - 6. CWP Rating: 150 psig.
 - 7. Maximum Operating Temperature: 225 deg F.

C. Manual Air Vents:

1. Body: Bronze.
2. Internal Parts: Nonferrous.
3. Operator: Key furnished with valve, or screwdriver bit.
4. Inlet Connection: NPS 1/2.
5. Discharge Connection: NPS 1/8.
6. CWP Rating: 150 psig.
7. Maximum Operating Temperature: 225 deg F.

D. Balancing Valves:

1. Body: Bronze, ball or plug, or globe cartridge type.
2. Ball or Plug: Brass or stainless steel.
3. Globe Cartridge and Washer: Brass with EPDM composition washer.
4. Seat: PTFE.
5. Visual Flow Indicator: Flowmeter with visible indication in a clear plastic cap at top of valve.
6. Differential Pressure Gage Connections: Integral seals for portable meter to measure loss across calibrated orifice.
7. Handle Style: Lever or knob, with memory stop to retain set position if used for shutoff.
8. CWP Rating: Minimum 125 psig.
9. Maximum Operating Temperature: 250 deg F.

E. Thermometers:

1. Mount on supply and return connections.
2. Case: Dry type, metal, 2-inch diameter.
3. Element: Bourdon tube or other type of pressure element.
4. Movement: Mechanical, connecting element and pointer.
5. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.
6. Pointer: Black metal.
7. Window: Plastic.
8. Connector: Rigid, back type.
9. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass 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.

F. Mounting Brackets: Copper, or copper-clad steel, where in contact with manifold.

2.3 PIPING SPECIALTIES

A. Cable Ties:

1. Fungus-inert, self-extinguishing, one-piece, self-locking, Type 6/6 nylon cable ties.
2. Minimum Width: 1/8 inch.
3. Tensile Strength: 20 lb, minimum.
4. Temperature Range: Minus 40 to plus 185 deg F.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine surfaces and substrates to receive radiant-heating piping for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
 - 1. Ensure that surfaces and pipes in contact with radiant-heating piping are free of burrs and sharp protrusions.
 - 2. Ensure that surfaces and substrates are level and plumb.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Install the following types of radiant-heating piping for the applications described:
 - 1. Piping in Interior Reinforced-Concrete Floors: PEX.

3.3 INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such 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 or coordination drawings.
- B. Install radiant-heating piping continuous from the manifold through the heated panel and back to the manifold without piping joints in heated panels.
- C. Connect radiant piping to manifold in a reverse-return arrangement.
- D. Do not bend pipes in radii smaller than manufacturer's minimum bend radius dimensions.
- E. Install manifolds in accessible locations, or install access panels to provide maintenance access as required in Section 083113 "Access Doors and Frames."
- F. Comply with requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties" for pipes and connections to hydronic systems and for glycol-solution fill requirements.
- G. Fire- and Smoke-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials according to Section 078413 "Penetration Firestopping."
- H. Piping in Interior Reinforced-Concrete Floors:
 - 1. Secure piping in concrete floors by attaching pipes to reinforcement using cable ties.
 - 2. Space cable ties a maximum of 18 inches o.c. and at center of turns or bends.

3. Maintain 2-inch minimum cover.
 4. Install a sleeve of 3/8-inch- thick, foam-type insulation or PE pipe around tubing and extending for a minimum of 10 inches on each side of slab joints to protect the tubing passing through expansion or control joints. Anchor sleeve to slab form at control joints to provide maximum clearance for saw cut.
 5. Maintain minimum 40-psig pressure in piping during concrete placement and continue for 24 hours after placement.
- I. Revise locations and elevations from those indicated as required to suit field conditions and ensure integrity of piping and as approved by Architect.
- J. After system balancing has been completed, mark balancing valves to permanently indicate final position.
- K. Perform the following adjustments before operating the system:
1. Open valves to fully open position.
 2. Check operation of automatic valves.
 3. Set temperature controls so all zones call for full flow.
 4. Purge air from piping.
- L. After concrete has cured as recommended by concrete supplier, operate radiant-heating system as follows:
1. Start system heating at a maximum of 10 deg F above the ambient radiant-panel temperature and increase 10 deg F each following day until design temperature is achieved.
 2. For freeze protection, operate at a minimum of 60 deg F supply-water temperature.

3.4 FIELD QUALITY CONTROL

- A. Prepare radiant-heating piping for testing as follows:
1. Open all isolation valves and close bypass valves.
 2. Open and verify operation of zone control valves.
 3. Flush with clean water and clean strainers.
- B. Perform the following tests and inspections:
1. Leak Test: After installation, charge system and test for leaks. Subject piping to hydrostatic test pressure that is not less than 1.5 times the design pressure but not more than 100 psig. Repair leaks and retest until no leaks exist.
 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Radiant-heating piping will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

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- E. Protect hydronic piping system from damage during construction.

END OF SECTION

SECTION 238413.29 - SELF-CONTAINED STEAM HUMIDIFIERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Self-contained electrode humidifiers.

1.3 DEFINITIONS

- A. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

1.4 ACTION SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Product Data: For each type of product. Include rated capacities, operating characteristics, furnished specialties, and accessories. On data submittal sheets where more than one product is described, clearly annotate which product(s) is to be supplied.
- C. Shop Drawings: Detail fabrication and installation of humidifiers. Include piping details, plans, elevations, sections, details of components, distributor tubes/manifolds, and attachments to other work.
 - 1. Include diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Coordination Drawings: Detail humidifiers and adjacent equipment. 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, based on input from installers of the items involved:

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1. Structural members to which humidifiers will be attached.
2. Size and location of initial access modules for acoustical tile.

C. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Submittals shall comply with the requirements of Section 013300 "Submittal Procedures" and the individual sections specifying the work.
- B. Operation and Maintenance Data: For humidifiers to include in operation and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Supply one replacement electrode cylinder with each self-contained humidifier.

1.8 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An NRTL.

1.9 COORDINATION

- A. Coordinate location and installation of humidifiers with distributor tubes/manifolds in ducts and plenums or occupied space. Revise locations and elevations to suit field conditions and to ensure proper humidifier operation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with AHRI 640.
- C. Comply with UL 998.
- D. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 1. Flame-Spread Index: 25 or less.

2. Smoke-Developed Index: 50 or less.

2.2 SELF-CONTAINED ELECTRODE HUMIDIFIERS

- A. Water Type: Suitable for use with tap water.
- B. Cylinders: Replaceable plastic humidifier water reservoir, steel electrode assembly, suitable for use with tap water.
- C. Cabinet:
 1. Baked-enamel, Powder-coated-steel, or stainless-steel enclosure houses heater cylinder, electrical wiring, components, controls, and control panel. Cabinet shall be factory insulated for safe operating surface temperature.
 2. Hinged or removable cover, keyed to restrict unauthorized access.
 3. Plumbing and electrical components housed in separate compartments of the cabinet.
 4. Threaded outlet in bottom of cabinet for drain piping.
- D. Control Panel:
 1. Microprocessor-based control system for modulating control.
 2. Factory-wired disconnect switch.
 3. Liquid-crystal display.
 4. Programmable keypad.
 5. Low-voltage control circuit.
 6. Diagnostic, maintenance, alarm, and status features.
 7. Safety switch interlocked to shut off heaters when cabinet is open.
 8. Internal electrical controls prewired to appropriately marked terminals for field connection.
 9. Electrical terminals for connection to each controlling device and alarm.
 10. Building Automation System Interface:
 - a. Full communication interface: BACnet.
- E. Controls:
 1. Solenoid fill valve and automatic drain valve or drain pump maintain water level. Include bronze inlet strainer, bronze solenoid fill valve with flow regulator, bronze solenoid drain valve or drain pump, and fill tee with built-in air gap to prevent back siphoning.
 2. Controls shall drain tanks if no demand for humidification for more than 72 hours.
 3. Set-point adjustment.
 4. Electrode current shutdown upon sensing unsafe condition (e.g., drain system malfunction, fill system malfunction, or overcurrent malfunction).
 5. Tri-conductivity sensor probes for water-level control.
- F. Atmospheric Steam Distributer Tube(s): Single or multiple, atmospheric steam distributer tube extending across entire width of duct or plenum and equipped with mounting brackets on ends. Nozzles/metered orifices are spaced evenly along distributer tubes and provide dry and uniform steam distribution.

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1. Material: Stainless steel.
2. Insulation: Insulated, minimum R-0.5.

G. Accessories:

1. Duct-mounted, high-limit humidistat.
2. Airflow switch prevents humidifier operation without airflow.
3. Steam and Condensate Hoses: For interconnection of humidifier to distributor tube(s)/manifold.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine ducts, air-handling units, and conditions for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in for piping systems to verify actual locations of piping connections before humidifier installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install humidifiers with required clearance for service and maintenance. Maintain path, downstream from humidifiers, clear of obstructions as required by ASHRAE 62.1.
- B. Seal all duct and plenum penetrations with flange.
- C. Install humidifier assemblies in metal ducts and casings constructed according to SMACNA's "HVAC Duct Construction Standards, Metal and Flexible."
- D. Install stainless-steel drain pan under each manifold mounted in duct.
 1. Construct drain pans with connection for drain; insulated and complying with ASHRAE 62.1.
 2. Connect to condensate trap and drainage piping.
 3. Extend drain pan upstream and downstream from tube(s)/manifold a minimum distance recommended by manufacturer but not less than required by ASHRAE 62.1.
- E. Install tube(s)/manifold supply piping pitched to drain condensate back to humidifier or as recommended by manufacturer.
- F. Equipment Mounting:
 1. Install floor-mounted humidifiers on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."

2. Install wall-mounted humidifiers in accordance with manufacturer's written instructions.
3. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

- G. Install all manufacturer-furnished accessories in accordance with manufacturer's written installation instructions.

3.3 PIPING CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

1. Install piping adjacent to humidifiers to allow service and maintenance.
2. Install shutoff valve, strainer, backflow preventer, and union in humidifier makeup line.

- B. Install piping specialties furnished by manufacturer but not factory mounted.

3.4 ELECTRICAL CONNECTIONS

- A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

- B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

- C. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.
2. Locate nameplate where easily visible.

3.5 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.

- B. Connect control wiring between control devices.

- C. Connect control wiring according to Section 260523 "Control Voltage Electrical Power Cables."

3.6 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

- B. Perform the following tests and inspections with the assistance of a factory-authorized service agent:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Humidifier will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.7 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain humidifiers.

END OF SECTION

OAK POINT
ASSOCIATES



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